AMC South Parking Lot Redevelopment

Framingham and Natick, Massachusetts

PREPARED FOR

BRE Shoppers World, LLC
3300 Enterprise Parkway
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PREPARED BY

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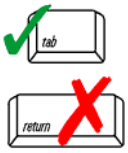
Checklist for Stormwater Report

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

A. Introduction

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.



A Stormwater Report must be submitted with the Notice of Intent permit application to document compliance with the Stormwater Management Standards. The following checklist is NOT a substitute for the Stormwater Report (which should provide more substantive and detailed information) but is offered here as a tool to help the applicant organize their Stormwater Management documentation for their Report and for the reviewer to assess this information in a consistent format. As noted in the Checklist, the Stormwater Report must contain the engineering computations and supporting information set forth in Volume 3 of the Massachusetts Stormwater Handbook. The Stormwater Report must be prepared and certified by a Registered Professional Engineer (RPE) licensed in the Commonwealth.

The Stormwater Report must include:

- The Stormwater Checklist completed and stamped by a Registered Professional Engineer (see page 2) that certifies that the Stormwater Report contains all required submittals.[1] This Checklist is to be used as the cover for the completed Stormwater Report.
- Applicant/Project Name
- Project Address
- Name of Firm and Registered Professional Engineer that prepared the Report
- Long-Term Pollution Prevention Plan required by Standards 4-6
- Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan required by Standard 8[2]
- Operation and Maintenance Plan required by Standard 9

In addition to all plans and supporting information, the Stormwater Report must include a brief narrative describing stormwater management practices, including environmentally sensitive site design and LID techniques, along with a diagram depicting runoff through the proposed BMP treatment train. Plans are required to show existing and proposed conditions, identify all wetland resource areas, NRCS soil types, critical areas, Land Uses with Higher Potential Pollutant Loads (LUHPPL), and any areas on the site where infiltration rate is greater than 2.4 inches per hour. The Plans shall identify the drainage areas for both existing and proposed conditions at a scale that enables verification of supporting calculations.

As noted in the Checklist, the Stormwater Management Report shall document compliance with each of the Stormwater Management Standards as provided in the Massachusetts Stormwater Handbook. The soils evaluation and calculations shall be done using the methodologies set forth in Volume 3 of the Massachusetts Stormwater Handbook.

To ensure that the Stormwater Report is complete, applicants are required to fill in the Stormwater Report Checklist by checking the box to indicate that the specified information has been included in the Stormwater Report. If any of the information specified in the checklist has not been submitted, the applicant must provide an explanation. The completed Stormwater Report Checklist and Certification must be submitted with the Stormwater Report.

[1] The Stormwater Report may also include the Illicit Discharge Compliance Statement required by Standard 10. If not included in the Stormwater Report, the Illicit Discharge Compliance Statement must be submitted prior to the discharge of stormwater runoff to the post-construction best management practices.

[2] For some complex projects, it may not be possible to include the Construction Period Erosion and Sedimentation Control Plan in the Stormwater Report. In that event, the issuing authority has the discretion to issue an Order of Conditions that approves the project and includes a condition requiring the proponent to submit the Construction Period Erosion and Sedimentation Control Plan before commencing any land disturbance activity on the site.

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

B. Stormwater Checklist and Certification

The following checklist is intended to serve as a guide for applicants as to the elements that ordinarily need to be addressed in a complete Stormwater Report. The checklist is also intended to provide conservation commissions and other reviewing authorities with a summary of the components necessary for a comprehensive Stormwater Report that addresses the ten Stormwater Standards.

Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the item is not applicable (N.A.) and provide the reasons for that determination.

A complete checklist must include the Certification set forth below signed by the Registered Professional Engineer who prepared the Stormwater Report.

Registered Professional Engineer's Certification

I have reviewed the Stormwater Report, including the soil evaluation, computations, Long-term Pollution Prevention Plan, the Construction Period Erosion and Sedimentation Control Plan (if included), the Long-term Post-Construction Operation and Maintenance Plan, the Illicit Discharge Compliance Statement (if included) and the plans showing the stormwater management system, and have determined that they have been prepared in accordance with the requirements of the Stormwater Management Standards as further elaborated by the Massachusetts Stormwater Handbook. I have also determined that the information presented in the Stormwater Checklist is accurate and that the information presented in the Stormwater Report accurately reflects conditions at the site as of the date of this permit application.

Registered Professional Engineer Block and Signature

Signature and Date 8/6/15

Checklist

Project Type: Is the application for new development, redevelopment, or a mix of new and redevelopment?

☐ New development

☑ Redevelopment

☐ Mix of New Development and Redevelopment

Checklist for Stormwater Report

Checklist (continued)

LID Measures: Stormwater Standards require LID measures to be considered. Document what environmentally sensitive design and LID Techniques were considered during the planning and design of the project:

- [x] No disturbance to any Wetland Resource Areas
- [ ] Site Design Practices (e.g. clustered development, reduced frontage setbacks)
- [x] Reduced Impervious Area (Redevelopment Only)
- [x] Minimizing disturbance to existing trees and shrubs
- [ ] LID Site Design Credit Requested:
  - [ ] Credit 1
  - [ ] Credit 2
  - [ ] Credit 3
- [ ] Use of "country drainage" versus curb and gutter conveyance and pipe
- [ ] Bioretention Cells (includes Rain Gardens)
- [ ] Constructed Stormwater Wetlands (includes Gravel Wetlands designs)
- [ ] Treebox Filter
- [ ] Water Quality Swale
- [ ] Grass Channel
- [ ] Green Roof
- [x] Other (describe): Subsurface Infiltration

Standard 1: No New Untreated Discharges

- [x] No new untreated discharges
- [x] Outlets have been designed so there is no erosion or scour to wetlands and waters of the Commonwealth
- [x] Supporting calculations specified in Volume 3 of the Massachusetts Stormwater Handbook included.

Checklist for Stormwater Report

Checklist (continued)

Standard 2: Peak Rate Attenuation

☐ Standard 2 waiver requested because the project is located in land subject to coastal storm flowage and stormwater discharge is to a wetland subject to coastal flooding.

☑ Evaluation provided to determine whether off-site flooding increases during the 100-year 24-hour storm.

☐ Calculations provided to show that post-development peak discharge rates do not exceed pre-development rates for the 2-year and 10-year 24-hour storms. If evaluation shows that off-site flooding increases during the 100-year 24-hour storm, calculations are also provided to show that post-development peak discharge rates do not exceed pre-development rates for the 100-year 24-hour storm.

Standard 3: Recharge

☑ Soil Analysis provided.

☑ Required Recharge Volume calculation provided.

☐ Required Recharge volume reduced through use of the LID site Design Credits.

☑ Sizing the infiltration, BMPs is based on the following method: Check the method used.

☑ Static ☐ Simple Dynamic ☐ Dynamic Field[1]

☐ Runoff from all impervious areas at the site discharging to the infiltration BMP.

☑ Runoff from all impervious areas at the site is *not* discharging to the infiltration BMP and calculations are provided showing that the drainage area contributing runoff to the infiltration BMPs is sufficient to generate the required recharge volume.

☑ Recharge BMPs have been sized to infiltrate the Required Recharge Volume.

☐ Recharge BMPs have been sized to infiltrate the Required Recharge Volume *only* to the maximum extent practicable for the following reason:

- ☐ Site is comprised solely of C and D soils and/or bedrock at the land surface
- ☐ M.G.L. c. 21E sites pursuant to 310 CMR 40.0000
- ☐ Solid Waste Landfill pursuant to 310 CMR 19.000
- ☐ Project is otherwise subject to Stormwater Management Standards only to the maximum extent practicable.

☑ Calculations showing that the infiltration BMPs will drain in 72 hours are provided.

☐ Property includes a M.G.L. c. 21E site or a solid waste landfill and a mounding analysis is included.

[1] 80% TSS removal is required prior to discharge to infiltration BMP if Dynamic Field method is used.

Checklist for Stormwater Report

Checklist (continued)

Standard 3: Recharge (continued)

☐ The infiltration BMP is used to attenuate peak flows during storms greater than or equal to the 10-year 24-hour storm and separation to seasonal high groundwater is less than 4 feet and a mounding analysis is provided.

☑ Documentation is provided showing that infiltration BMPs do not adversely impact nearby wetland resource areas.

Standard 4: Water Quality

The Long-Term Pollution Prevention Plan typically includes the following:

- Good housekeeping practices;
- Provisions for storing materials and waste products inside or under cover;
- Vehicle washing controls;
- Requirements for routine inspections and maintenance of stormwater BMPs;
- Spill prevention and response plans;
- Provisions for maintenance of lawns, gardens, and other landscaped areas;
- Requirements for storage and use of fertilizers, herbicides, and pesticides;
- Pet waste management provisions;
- Provisions for operation and management of septic systems;
- Provisions for solid waste management;
- Snow disposal and plowing plans relative to Wetland Resource Areas;
- Winter Road Salt and/or Sand Use and Storage restrictions;
- Street sweeping schedules;
- Provisions for prevention of illicit discharges to the stormwater management system;
- Documentation that Stormwater BMPs are designed to provide for shutdown and containment in the event of a spill or discharges to or near critical areas or from LUHPPL;
- Training for staff or personnel involved with implementing Long-Term Pollution Prevention Plan;
- List of Emergency contacts for implementing Long-Term Pollution Prevention Plan.

☑ A Long-Term Pollution Prevention Plan is attached to Stormwater Report and is included as an attachment to the Wetlands Notice of Intent.

☑ Treatment BMPs subject to the 44% TSS removal pretreatment requirement and the one inch rule for calculating the water quality volume are included, and discharge:

- ☐ is within the Zone II or Interim Wellhead Protection Area
- ☐ is near or to other critical areas
- ☐ is within soils with a rapid infiltration rate (greater than 2.4 inches per hour)
- ☐ involves runoff from land uses with higher potential pollutant loads.

☐ The Required Water Quality Volume is reduced through use of the LID site Design Credits.

☑ Calculations documenting that the treatment train meets the 80% TSS removal requirement and, if applicable, the 44% TSS removal pretreatment requirement, are provided.

Checklist for Stormwater Report

Checklist (continued)

Standard 4: Water Quality (continued)

☐ The BMP is sized (and calculations provided) based on:

☑ The ½" or 1" Water Quality Volume or

☐ The equivalent flow rate associated with the Water Quality Volume and documentation is provided showing that the BMP treats the required water quality volume.

☑ The applicant proposes to use proprietary BMPs, and documentation supporting use of proprietary BMP and proposed TSS removal rate is provided. This documentation may be in the form of the propriety BMP checklist found in Volume 2, Chapter 4 of the Massachusetts Stormwater Handbook and submitting copies of the TARP Report, STEP Report, and/or other third party studies verifying performance of the proprietary BMPs.

☐ A TMDL exists that indicates a need to reduce pollutants other than TSS and documentation showing that the BMPs selected are consistent with the TMDL is provided.

Standard 5: Land Uses With Higher Potential Pollutant Loads (LUHPPLs)

☐ The NPDES Multi-Sector General Permit covers the land use and the Stormwater Pollution Prevention Plan (SWPPP) has been included with the Stormwater Report.

☐ The NPDES Multi-Sector General Permit covers the land use and the SWPPP will be submitted ***prior to*** the discharge of stormwater to the post-construction stormwater BMPs.

☑ The NPDES Multi-Sector General Permit does ***not*** cover the land use.

☐ LUHPPLs are located at the site and industry specific source control and pollution prevention measures have been proposed to reduce or eliminate the exposure of LUHPPLs to rain, snow, snow melt and runoff, and been included in the long term Pollution Prevention Plan.

☐ All exposure has been eliminated.

☐ All exposure has ***not*** been eliminated and all BMPs selected are on MassDEP LUHPPL list.

☑ The LUHPPL has the potential to generate runoff with moderate to higher concentrations of oil and grease (e.g. all parking lots with >1000 vehicle trips per day) and the treatment train includes an oil grit separator, a filtering bioretention area, a sand filter or equivalent.

Standard 6: Critical Areas

☐ The discharge is near or to a critical area and the treatment train includes only BMPs that MassDEP has approved for stormwater discharges to or near that particular class of critical area.

☐ Critical areas and BMPs are identified in the Stormwater Report.

Checklist for Stormwater Report

Checklist (continued)

Standard 7: Redevelopments and Other Projects Subject to the Standards only to the maximum extent practicable

☐ The project is subject to the Stormwater Management Standards only to the maximum Extent Practicable as a:

- ☐ Limited Project
- ☐ Small Residential Projects: 5-9 single family houses or 5-9 units in a multi-family development provided there is no discharge that may potentially affect a critical area.
- ☐ Small Residential Projects: 2-4 single family houses or 2-4 units in a multi-family development with a discharge to a critical area
- ☐ Marina and/or boatyard provided the hull painting, service and maintenance areas are protected from exposure to rain, snow, snow melt and runoff
- ☐ Bike Path and/or Foot Path
- ☑ Redevelopment Project
- ☐ Redevelopment portion of mix of new and redevelopment.

☑ Certain standards are not fully met (Standard No. 1, 8, 9, and 10 must always be fully met) and an explanation of why these standards are not met is contained in the Stormwater Report.

☑ The project involves redevelopment and a description of all measures that have been taken to improve existing conditions is provided in the Stormwater Report. The redevelopment checklist found in Volume 2 Chapter 3 of the Massachusetts Stormwater Handbook may be used to document that the proposed stormwater management system (a) complies with Standards 2, 3 and the pretreatment and structural BMP requirements of Standards 4-6 to the maximum extent practicable and (b) improves existing conditions.

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control

A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan must include the following information:

- Narrative;
- Construction Period Operation and Maintenance Plan;
- Names of Persons or Entity Responsible for Plan Compliance;
- Construction Period Pollution Prevention Measures;
- Erosion and Sedimentation Control Plan Drawings;
- Detail drawings and specifications for erosion control BMPs, including sizing calculations;
- Vegetation Planning;
- Site Development Plan;
- Construction Sequencing Plan;
- Sequencing of Erosion and Sedimentation Controls;
- Operation and Maintenance of Erosion and Sedimentation Controls;
- Inspection Schedule;
- Maintenance Schedule;
- Inspection and Maintenance Log Form.

☑ A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan containing the information set forth above has been included in the Stormwater Report.

Checklist for Stormwater Report

Checklist (continued)

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control (continued)

☐ The project is highly complex and information is included in the Stormwater Report that explains why it is not possible to submit the Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan with the application. A Construction Period Pollution Prevention and Erosion and Sedimentation Control has ***not*** been included in the Stormwater Report but will be submitted ***before*** land disturbance begins.

☐ The project is ***not*** covered by a NPDES Construction General Permit.

☐ The project is covered by a NPDES Construction General Permit and a copy of the SWPPP is in the Stormwater Report.

☑ The project is covered by a NPDES Construction General Permit but no SWPPP been submitted. The SWPPP will be submitted BEFORE land disturbance begins.

Standard 9: Operation and Maintenance Plan

☑ The Post Construction Operation and Maintenance Plan is included in the Stormwater Report and includes the following information:

- ☑ Name of the stormwater management system owners;
- ☑ Party responsible for operation and maintenance;
- ☑ Schedule for implementation of routine and non-routine maintenance tasks;
- ☑ Plan showing the location of all stormwater BMPs maintenance access areas;
- ☐ Description and delineation of public safety features;
- ☐ Estimated operation and maintenance budget; and
- ☑ Operation and Maintenance Log Form.

☐ The responsible party is ***not*** the owner of the parcel where the BMP is located and the Stormwater Report includes the following submissions:

- ☐ A copy of the legal instrument (deed, homeowner's association, utility trust or other legal entity) that establishes the terms of and legal responsibility for the operation and maintenance of the project site stormwater BMPs;
- ☐ A plan and easement deed that allows site access for the legal entity to operate and maintain BMP functions.

Standard 10: Prohibition of Illicit Discharges

☑ The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges;

☐ An Illicit Discharge Compliance Statement is attached;

☑ NO Illicit Discharge Compliance Statement is attached but will be submitted ***prior to*** the discharge of any stormwater to post-construction BMPs.

Stormwater Report Narrative

This Stormwater Report has been prepared to demonstrate compliance with the Massachusetts Stormwater Management Standards in accordance with the Massachusetts Wetlands Protection Act Regulations (310 CMR 10.00) and Water Quality Certification Regulations (314 CMR 9.00). This report also demonstrates compliance with the Framingham and Natick rules and regulations for stormwater design and mitigation.

Project Description

The Applicant, BRE DDR Shoppers World, LLC, is proposing to construct a mixed use redevelopment (the Project) on the existing overflow parking on the AMC parcel. As proposed, the Project consists of approximately 9,500 square feet of restaurant space, a 21,000 square foot bowling alley, and 5,400 square feet of entertainment space along with ancillary landscape improvements, parking spaces (386), and utility improvements to support these uses.

The proposed restaurant and entertainment uses will generate over 1,000 vehicle trips per day and therefore is considered a Land Use with Higher Potential Pollutant Loads (LUHPPL).

Site Description

The proposed redevelopment is approximately 16.6-acres on the Framingham-Natick town line border located at 1391 Worcester Street in Natick and 19 Flutie Pass in Framingham (Project Site). The Site lies within the Sudbury River watershed. The Project Site consists of existing parking lots, landscaped trees, and an overhead transmission line with structures spanning from southwest to northeast across the parking lots. Areas surrounding the Project Site consist of Shoppers World to the west, the Natick Mall to the east, a movie theater to the north, and Route 9 to the south. The Framingham-Natick property line extends through the Project Site. The existing parking lots serve as additional parking spaces for the movie theater but generally remain underutilized. Please refer to Figure 1 for additional details.

The elevation of the site ranges from 160 to 170 feet (NAVD). The high point occurs in the northwest corner and slopes downward towards the low point in the northeast corner. According to the regional Natural Resource Conservation Soil survey[1], the soils mapped on the Project Site include Swansea muck, Ridgebury fine sandy loam, Charlton-Hollis outcrop, and Scituate fine sandy loam.

Wetland Resource Areas on the Site include the following:

[1] USDA Natural Resources Conservation Service, 2014. *Soil Survey of Middlesex County, Massachusetts.*

Table 1
Wetland Resource Areas

Name	*Critical Area*	*Zone 1 or Zone A*	*ORW or SRW*	*Zone II or IWPA*	*Other*
Wetland 1	No	No	No	No	
Riverfront Area	No	No	No	No	

For additional information regarding the wetland resource areas present on the site see the Project Notice of Intent prepared by VHB dated July 2015.

According to the National Resources Conservation Service (NRCS), surface soils on the Site include Swansea muck, Ridgebury fine sandy loam, Charlton-Hollis outcrop, and Scituate fine sandy loam. On-site soils are classified mainly as Hydrologic Soil Groups (HSG) A with a small portion of the Site classified as D. Based on the soil evaluation included in Appendix C, the Site is not considered to be within an area of rapid infiltration.

Existing Drainage Conditions

Under existing conditions, the Site is developed with a mix of impervious and pervious surfaces, with generally flat topography. The impervious surface on site consists of mostly parking lot. The Site is divided into 5 drainage areas as stormwater runoff flows to 3 Design Points, which have been identified as DP-1, DP-2, and DP-3. The runoff from the parking lot is collected in catch basins and flows through a closed drainage system and discharges to a man-made wet detention pond The detention pond has an outlet control structure which regulates flow tot eh off-site wetland (Design point 1). The runoff from northwest region of the parking lot is collected in catch basins and discharges to a detention pond. The detention pond has an outlet control structure which then regulates the discharge of stormwater overland to Design point 2. Shoppers World Drive is collected in catch basins and discharges runoff to a manmade wet detention pond (Design Point 3)

Figure 2 illustrates the existing drainage patterns on the Site. Table 2 below provides a summary of the existing conditions hydrologic data.

Table 2
Existing Conditions Hydrologic Data

Drainage Area	*Discharge Location*	*Design Point*	*Area (acres)*	*Curve Number*	*Time of Concentration (min)*
1	1P	DP-1	3.7	89	5.0
2	1P	DP-1	1.0	86	5.0
3	2P	DP-2	0.8	81	5.0
4	DP-2	DP-2	1.1	36	5.0
5	DP-3	DP-3	0.8	92	5.0

Proposed Drainage Conditions

The proposed redevelopment has been designed to maintain the existing flow patterns to the maximum extent practicable. Stormwater will be collected in deep-sump and hooded catch basins, routed through stormwater management infrastructure to be treated, and discharged to the existing design points. The proposed stormwater management system will incorporate modern stormwater best management practices (BMPs) and low impact design (LID) techniques to promote infiltration, reduce the peak flow rates and volumes, and provide full water quality treatment prior to discharging stormwater off-site. Treatment of the stormwater will be provided by a subsurface infiltration system with an isolator row and the use of structural water quality devices.

The addition of a right turn lane from The Shoppers World Drive into the Project Site will result in a small increase in impervious area within that subcatchment. That subcatchment flows into the man-made detention pond (DP-3) and eventually discharges to the stream located to the south of the site (DP-1). The elevation of the man-made pond was analyzed and in the 100 year storm will increase by approximately 1.8". The man made detention pond has an outlet control structure which regulates the discharge. The small increase in the elevation of the pond will minimally affect the head at the outlet control structure, in turn minimally affecting the flow out of the pond. The stormwater improvements made on site and the reduction in peak rates on-site will also offset any increase in peak rate of the off-site improvements.

Figure 3 illustrates the proposed "post construction" drainage conditions for the project. As shown, the Site will be divided into 8 drainage areas that ultimately discharge treated stormwater to the 3 existing Design Points. Drainage divides in the proposed conditions were designed to match the existing conditions drainage divides to the maximum extent practicable. Table 3 below provides a summary of the proposed conditions hydrologic data.

Table 3
Proposed Conditions Hydrologic Data

Drainage Area	*Discharge Location*	*Design Point*	*Area (acres)*	*Curve Number*	*Time of Concentration (min)*
10	1P	DP-1	3.8	84	5.0
11A	1P	DP-1	0.5	98	5.0
11B	1P	DP-1	0.2	98	5.0
11C	1P	DP-1	0.2	98	5.0
20	DP-1	DP-1	0.2	39	5.0
30	2P	DP-2	0.8	86	5.0
40	DP-2	DP-2	0.9	35	5.0
50	DP-3	DP-3	0.8	97	5.0

Integrated into the site design is a comprehensive stormwater management system that has been developed in accordance with the Massachusetts Stormwater Handbook. The proposed stormwater management system has been designed to treat the half inch Water Quality Volume as the Site is not designated as a LUHPPL.

Environmentally Sensitive and Low Impact Development (LID) Techniques

Low Impact Development (LID) techniques and stormwater Best Management Practices (BMPs) have been integrated into the site design for the proposed redevelopment. These measures have been carefully selected and incorporated into the redevelopment of the site based on the specific site conditions and opportunities encountered in the design to mimic existing drainage patterns, reduce peak runoff rates, maximize infiltration and groundwater recharge, and treat for water quality. The proposed LID and BMP measures include deep-

sump and hooded catch basins, a subsurface infiltration system sized to treat the required water quality volume below the lowest outlet elevation, and structural water quality devices. Stormwater from the new proposed impervious surfaces are directed to these BMPs where it is treated for water quality. Further information on water quality treatment is discussed below in the Regulatory Compliance section of this report, and in Appendix D.

Closed-Drainage System

The closed drainage system has been designed to convey runoff from the 25-year storm event and the infiltration/detention areas are designed to accommodate the 100-year storm event. Drainage pipes were sized using Manning's equation for full-flow capacity and the Rational Method to estimate runoff. The performance of the system was analyzed using StormCAD, a HEC-22 based program. A summary table of the closed-drainage system analysis is included in Appendix H.

Regulatory Compliance

Massachusetts Department of Environmental Protection (DEP) - Stormwater Management Standards

As demonstrated below, the proposed Project fully complies with the DEP Stormwater Management Standards.

Standard 1: No New Untreated Discharges or Erosion to Wetlands

The Project has been designed to fully comply with Standard 1.

The Best Management Practices (BMPs) included in the proposed stormwater management system have been designed in accordance with the Massachusetts Stormwater Handbook. Supporting information and computations demonstrating that no new untreated discharges will result from the Project are presented through compliance with Standards 4 through 6.

All proposed Project stormwater outlets and conveyances have been designed to not cause erosion or scour to wetlands or receiving waters. Outlets from closed drainage systems have been designed with flared end sections and stone protection to dissipate discharge velocities. Overflows from BMP's that impound stormwater have been designed with stone to protect down gradient areas from erosion.

Computations and supporting information for the sizing and selection of materials used to protect from scour and erosion are included in Appendix A.

Standard 2: Peak Rate Attenuation

The Project is seeking relief under Stormwater Management Standard 7 and as such complies with Standard 2 to the maximum extent practicable.

The rainfall-runoff response of the Site under existing and proposed conditions was analyzed for storm events with recurrence intervals of 2, 10, 25 and 100-years. The results of the analysis, as summarized in Table 4 below, indicate that there is no increase in peak discharge rates between the existing and proposed conditions for Design points 1 and 2. The Shoppers World Drive subcatchment area will have an increase in impervious area and in turn an increase in peak rates due to the addition of a dedicated right turn lane as well as a dedicated left turn lane into the Site. That subcatchment flows into the man-made detention pond and eventually discharges to the stream located to the south of the site (DP-1). The elevation of the man-made pond was analyzed and in the 100 year storm will increase by approximately 1.8". The man made detention pond has an outlet control structure which regulates the flow from the pond. The pond has sufficient capacity to detain the minor increase in volume and will help to offset the increase in peak rates cause by the increase in impervious area. The

small increase in the elevation of the pond will minimally affect the head at the outlet control structure in turn minimally affecting the total flow out of the pond. The stormwater improvements made on site and the reduction in peak rates on-site will also offset any increase in peak rate of the off-site improvements. In turn there will be no downstream affects to the stormwater system.

Computations and supporting information regarding the hydrologic modeling are included in Appendix B.

Table 4
Peak Discharge Rates (cfs*)

Design Point	*2-year*	*10-year*	*25-year*	*100-year*
Design Point: DP-1 (South Wetland)				
Existing	7.9	14.0	19.2	30.1
Proposed	7.1	13.1	18.2	29.3*
Design Point: DP-2 (North Culvert)				
Existing	0.2	1.3	2.2	4.8
Proposed	0.0	0.7	1.3	4.6
Design Point: DP-3 (Shoppers World Drive)				
Existing	2.1	3.3	4.3	6.2
Proposed	2.5	3.7	4.7	6.7*

*Increase in flow to DP-3 is offset by reduction in flow to DP-1

Standard 3: Stormwater Recharge

The Project has been designed to fully comply with Standard 3.

In accordance with the Stormwater Handbook, the Required Recharge Volume for the Project is therefore 436 cubic feet. Recharge of stormwater has been provided through the use of a subsurface infiltration system, which have been sized using the Static method. Each infiltration BMP has been designed to drain completely within 72 hours. Table 5 below provides a summary of the proposed infiltration BMPs utilized for the Project.

Table 5
Summary of Recharge Calculations

Infiltration BMP	*Provided Recharge Volume (cubic feet)*
Subsurface Infiltration	2,582
Total Provided Recharge	2,582
Total Required Recharge	436

Soil evaluation (including Geotechnical Report), computations, and supporting information are included in Appendix C.

Standard 4: Water Quality

The Project has been designed to fully comply with Standard 4.

The proposed stormwater management system implements a treatment train of BMPs that has been designed to provide 80% TSS removal of stormwater runoff from all proposed impervious surfaces as well as 44% pretreatment prior to infiltration BMPs.

Computations and supporting information, including the Long-Term Pollution Prevention Plan, are included in Appendix D.

Standard 5: Land Uses with Higher Potential Pollutant Loads (LUHPPLs)

The Project is considered a LUHPPL and therefore has been designed with suitable BMPs sized to treat the 1-inch Water Quality Volume and provide the pretreatment requirement of 44% TSS removal prior to infiltration. Proposed source controls and pollution prevention measures have been identified in the Long-Term Pollution Prevention Plan included in Appendix D.

For computations and supporting information regarding the sizing of BMPs suitable for treatment of runoff from LUHPPLs, see Appendix D.

Standard 6: Critical Areas

The Project will not discharge stormwater near or to a critical area.

For computations and supporting information regarding the sizing of BMPs suitable for treatment of runoff near or to critical areas, see Appendix D.

Standard 7: Redevelopments and Other Projects Subject to the Standards only to the Maximum Extent Practicable

The Project is a redevelopment and has been designed to comply with Stormwater Management Standards 2-6 to the maximum extent practicable. Standards 8-10 have been met completely.

Refer directly to each Standard for applicable computations and supporting information demonstrating compliance with each.

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Controls

The Project will disturb approximately 7.3 acres of land and is therefore required to obtain coverage under the Environmental Protection Agency (EPA) National Pollutant Discharge Elimination System (NPDES) Construction General Permit. As required under this permit, a Stormwater Pollution Prevention Plan (SWPPP) will be developed and submitted before land disturbance begins. Recommended construction period pollution prevention and erosion and sedimentation controls to be finalized in the SWPPP are included in Appendix F.

Standard 9: Operation and Maintenance Plan

In compliance with Standard 9, a Post Construction Stormwater Operation and Maintenance (O&M) Plan has been developed for the Project. The O&M Plan is included in Appendix D as part of the Long Term Pollution Prevention Plan.

Standard 10: Prohibition of Illicit Discharges

Sanitary sewer and storm drainage structures remaining from previous development which are part of the redevelopment area will be removed or will be incorporated into updated sanitary sewer and separate stormwater sewer systems. The design plans submitted with this report have been designed so that the components included therein are in full compliance with current standards. No statement is made with regard to the drainage system in portions of the site not included in the redevelopment project area. The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges.

Figure 1
Site Locus Map

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Vanasse Hangen Brustlin, Inc.

0 250 500 Feet

Site Locus
Shoppers World
1391 Worcester Street
Natick/Framingham, MA

Figure 1
April 1, 2015

Figure 2
Existing Drainage Areas

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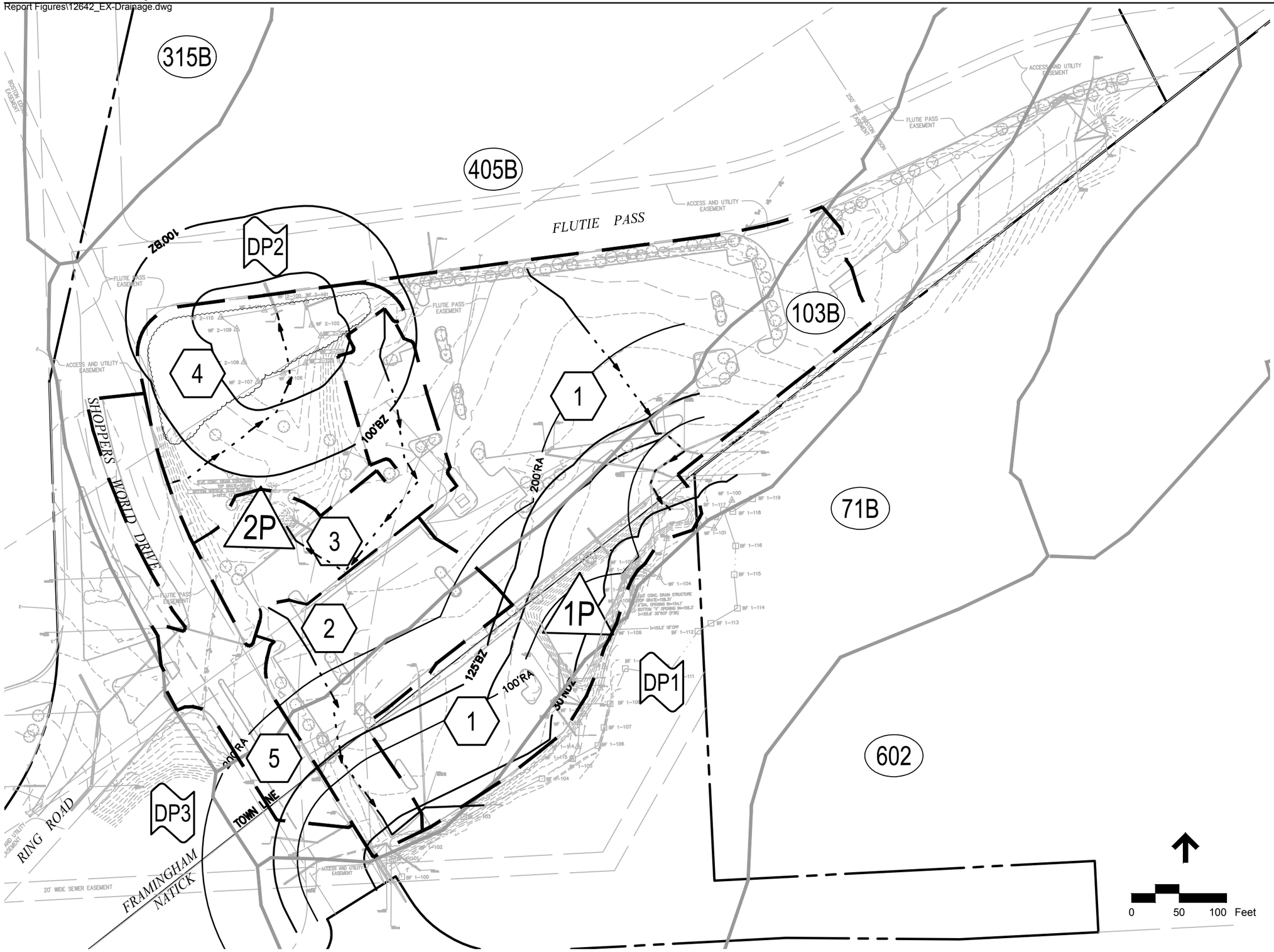

LEGEND

- POND
- DESIGN POINT
- DRAINAGE AREA DESIGNATION
- DRAINAGE AREA BOUNDARY
- TIME OF CONCENTRATION FLOW LINE
- SOIL TYPE BOUNDARY
- 100' BUFFER ZONE
- WETLAND BOUNDARY (4–220 / 4–219)

SCS SOIL CLASSIFICATIONS

315B	SCITUATE FINE SANDY LOAM, 3–8% SLOPES, HSG D
71B	RIDGEBURY FINE SANDY LOAM, 3–8% SLOPES, HSG D
103B	CHARLTON–HOLLIS–ROCK OUTCROP COMPLEX, 3–8% SLOPES, HSG A
405B	CHARLTON FINE SANDY LOAM, 3–8% SLOPES, HSG A
602	URBAN LAND

Vanasse Hangen Brustlin, Inc.

Figure 2 July 20, 2015

Existing Drainage Areas
Shoppers World
Framingham/Natick, MA

Figure 3
Proposed Drainage Areas

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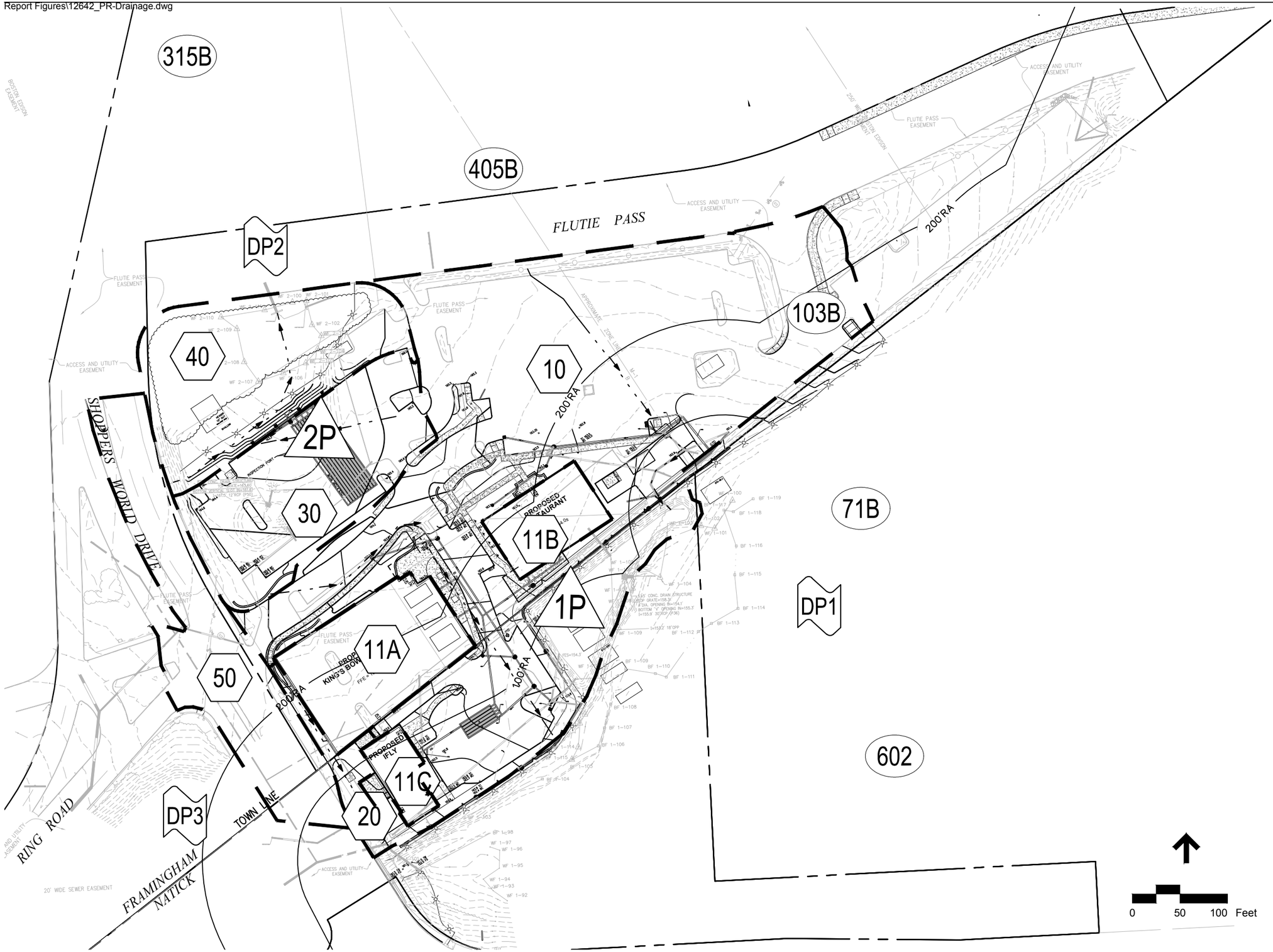


LEGEND

- 1 — POND
- 1 — DESIGN POINT
- 1 — DRAINAGE AREA DESIGNATION
- DRAINAGE AREA BOUNDARY
- TIME OF CONCENTRATION FLOW LINE
- SOIL TYPE BOUNDARY
- 100' BUFFER ZONE
- 4–220 4–219 WETLAND BOUNDARY

SCS SOIL CLASSIFICATIONS

- 315B — SCITUATE FINE SANDY LOAM, 3–8% SLOPES, HSG D
- 71B — RIDGEBURY FINE SANDY LOAM, 3–8% SLOPES, HSG D
- 103B — CHARLTON–HOLLIS–ROCK OUTCROP COMPLEX, 3–8% SLOPES, HSG A
- 405B — CHARLTON FINE SANDY LOAM, 3–8% SLOPES, HSG A
- 602 — URBAN LAND

Vanasse Hangen Brustlin, Inc.

Figure 3 December 8, 2015

Proposed Drainage Areas
Shoppers World
Framingham/Natick, MA

Appendix A
Standard 1 Computations

Included in this section:

- Stormwater Outlet Protection Calculations

Hydraulic Analysis Report

Project Data

Project Title: Shoppers World

Designer: PLH

Project Date: Friday, January 30, 2015

Project Units: U.S. Customary Units

Notes: FES A-1

Input Parameters

Riprap Type: Culvert Outlet Protection

Flow: 2.4 cfs

Culvert Diameter: 1 ft

Normal Depth in Culvert: 0.5 ft

Tailwater Depth: 0.4 ft

If tailwater is unknown, use 0.4D

flow is sbcritical

Result Parameters

Tailwater Depth Used in Computations: 0.4 ft

Culvert Diameter Used in Computations: 1 ft

Computed D50: 1.90588 in

Riprap Class

Riprap shape should be angular

Riprap Class Name: CLASS I

Riprap Class Order: 1

The following values are an 'average' of the size fraction range for the selected riprap class.

d100: 12 in

d85: 9 in

d50: 6.5 in

d15: 4.5 in

Layout Recommendations

Apron Length: 4 ft

Apron Depth: 1.89583 ft

Apron Width (at end): 5.66667 ft

No channel used in calculation

Reference: Outlet protection designed using the Federal Highway Administration (FHWA) Hydraulic Toolbox Program. The sizing methodology for culvert outlet protection is based on HEC-14, equation 10.

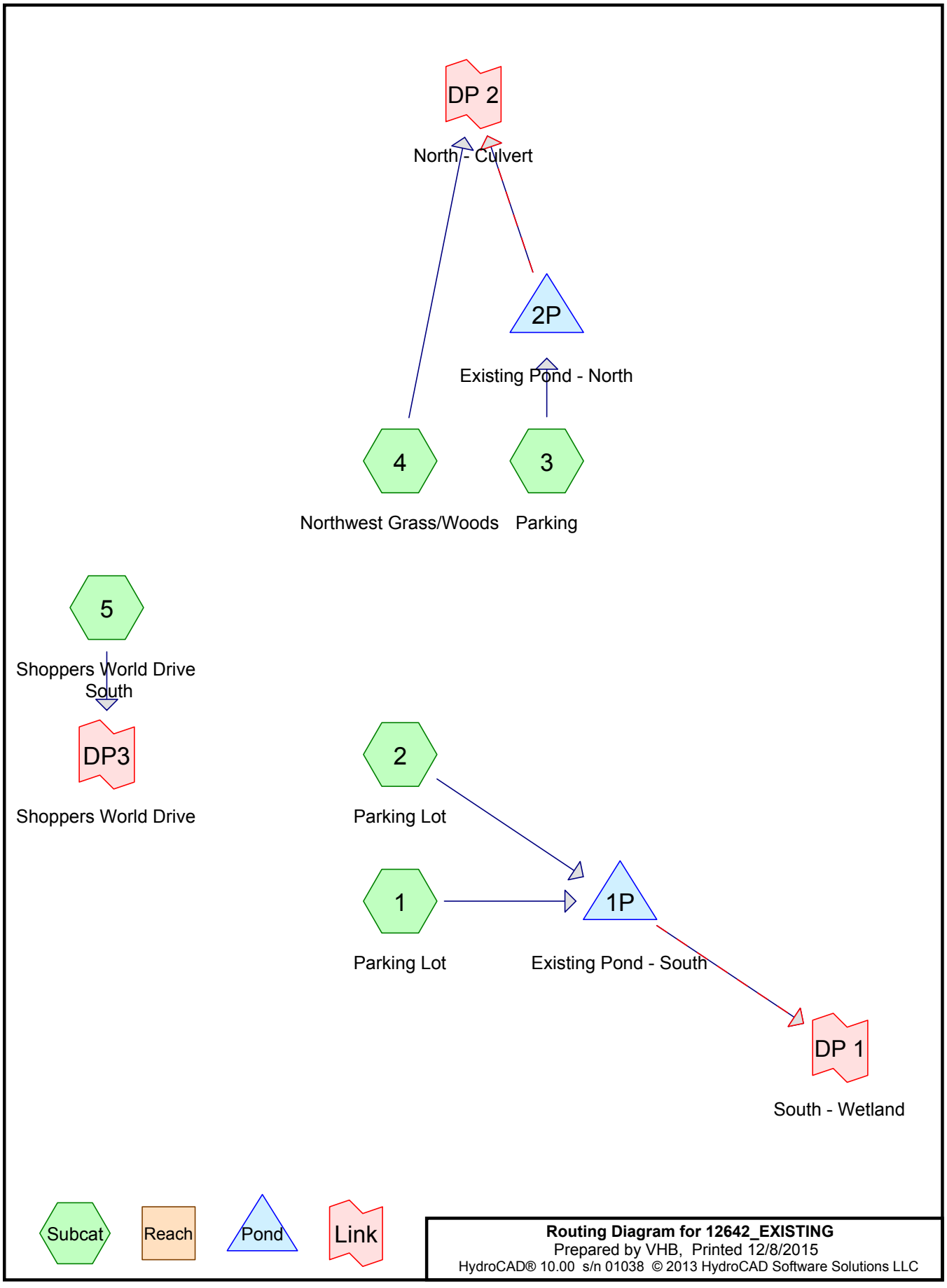
Appendix B
Standard 2 Computations and Supporting Information

Rainfall volumes used for this analysis were based on the Natural Resources Conservation Service (NRCS) Type III, 24-hour storm event for Middlesex County, Massachusetts. Runoff curve numbers for the existing and proposed conditions, as previously shown in Tables 1 and 2 respectively, were determined using NRCS Technical Release 55 (TR-55) methodology as provided in HydroCAD. The HydroCAD model is based on the NRCS Technical Release 20 (TR-20) Model for Project Formulation Hydrology.

Included in this section:

- HydroCAD Analysis: Existing Conditions
- HydroCAD Analysis: Proposed Conditions

HydroCAD Analysis: Existing Conditions


DP 2
North - Culvert
2P
Existing Pond - North
4
3
Northwest Grass/Woods
Parking
5
Shoppers World Drive South
DP3
Shoppers World Drive
2
Parking Lot
1
Parking Lot
1P
Existing Pond - South
DP 1
South - Wetland
Subcat
Reach
Pond
Link
Routing Diagram for 12642_EXISTING
Prepared by VHB, Printed 12/8/2015
HydroCAD® 10.00 s/n 01038 © 2013 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
75,350	39	>75% Grass cover, Good, HSG A (1, 2, 3, 4, 5)
3,850	80	>75% Grass cover, Good, HSG D (1)
160,250	98	Paved parking (1, 2)
53,900	98	Paved parking, HSG A (3, 5)
6,900	98	Water Surface, HSG A (1)
150	98	Water Surface, HSG D (1)
18,350	30	Woods, Good, HSG A (4)
318,750	**80**	**TOTAL AREA**

2- Year-Storm-Event-Existing

Summary for Subcatchment 1: Parking Lot

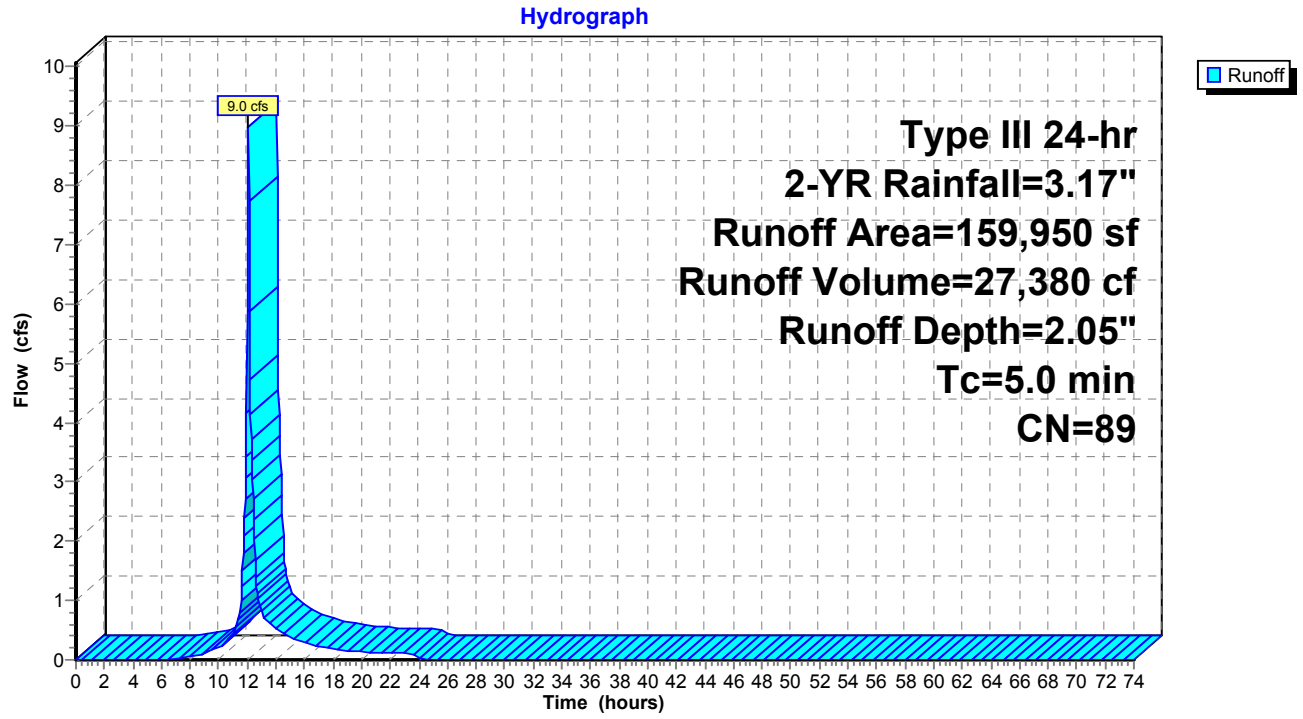
Runoff = 9.0 cfs @ 12.08 hrs, Volume= 27,380 cf, Depth= 2.05"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Type III 24-hr 2-YR Rainfall=3.17"

	Area (sf)	CN	Description
*	126,350	98	Paved parking
	22,700	39	>75% Grass cover, Good, HSG A
	3,850	80	>75% Grass cover, Good, HSG D
	6,900	98	Water Surface, HSG A
*	150	98	Water Surface, HSG D
	159,950	89	Weighted Average
	26,550		16.60% Pervious Area
	133,400		83.40% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 1: Parking Lot



Summary for Subcatchment 2: Parking Lot

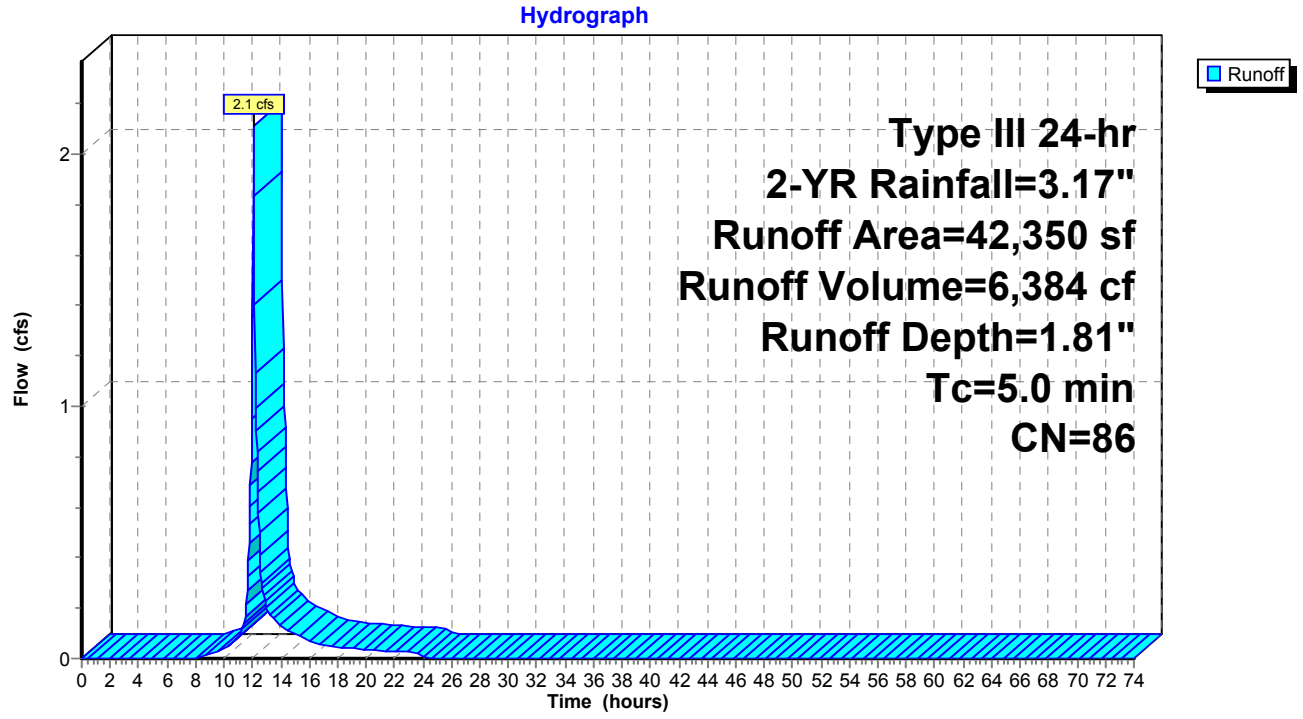
Runoff = 2.1 cfs @ 12.08 hrs, Volume= 6,384 cf, Depth= 1.81"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Type III 24-hr 2-YR Rainfall=3.17"

	Area (sf)	CN	Description
*	33,900	98	Paved parking
	8,450	39	>75% Grass cover, Good, HSG A
	42,350	86	Weighted Average
	8,450		19.95% Pervious Area
	33,900		80.05% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 2: Parking Lot



Summary for Subcatchment 3: Parking

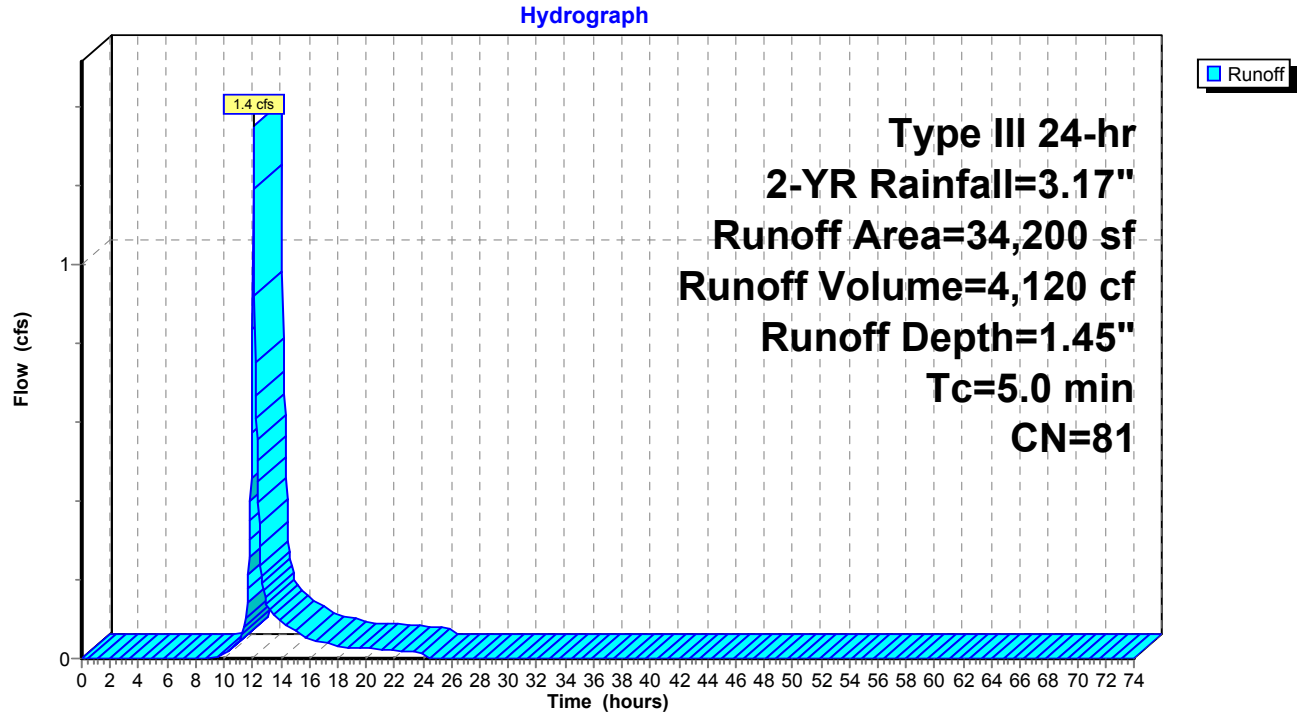
Runoff = 1.4 cfs @ 12.08 hrs, Volume= 4,120 cf, Depth= 1.45"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Type III 24-hr 2-YR Rainfall=3.17"

Area (sf)	CN	Description
24,350	98	Paved parking, HSG A
9,850	39	>75% Grass cover, Good, HSG A
34,200	81	Weighted Average
9,850		28.80% Pervious Area
24,350		71.20% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 3: Parking



Summary for Subcatchment 4: Northwest Grass/Woods

[45] Hint: Runoff=Zero

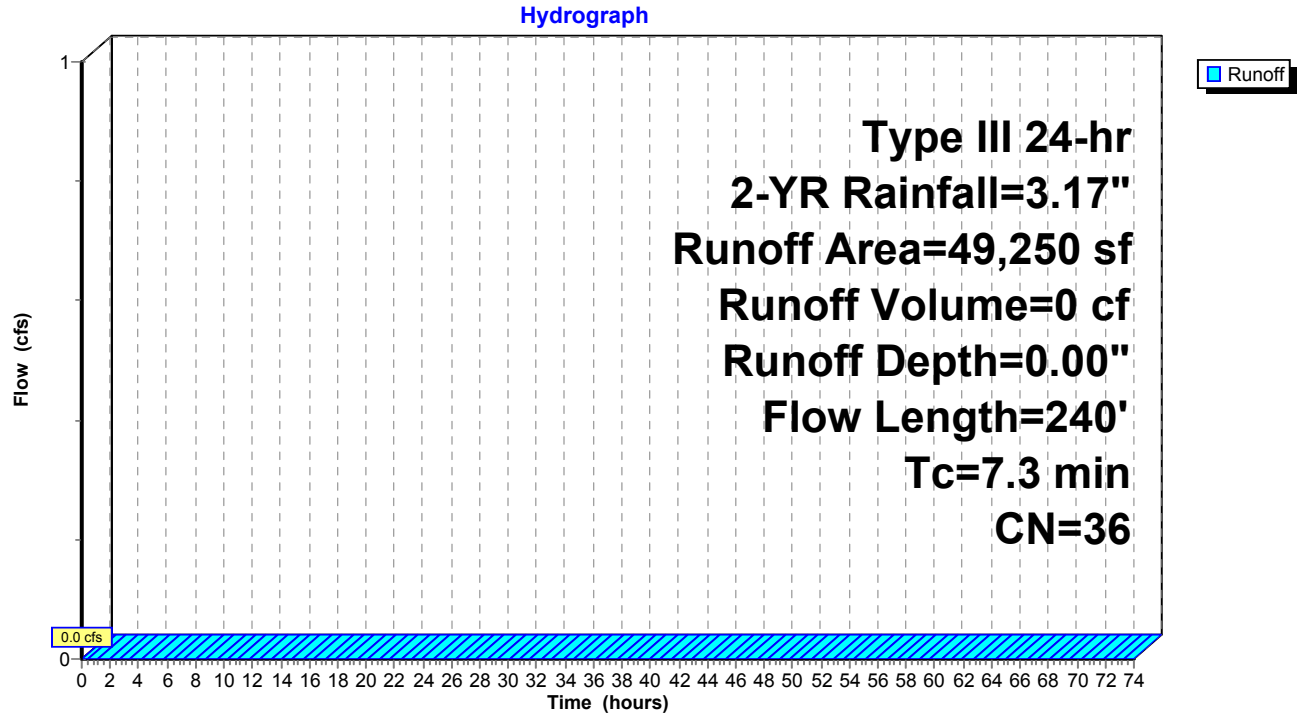
Runoff = 0.0 cfs @ 0.00 hrs, Volume= 0 cf, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Type III 24-hr 2-YR Rainfall=3.17"

Area (sf)	CN	Description
30,900	39	>75% Grass cover, Good, HSG A
18,350	30	Woods, Good, HSG A
49,250	36	Weighted Average
49,250		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	20	0.3000	0.35		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.00"
3.3	30	0.0300	0.15		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.00"
2.4	114	0.0130	0.80		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.7	76	0.0130	1.71		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
7.3	240	Total			

Subcatchment 4: Northwest Grass/Woods



Summary for Subcatchment 5: Shoppers World Drive South

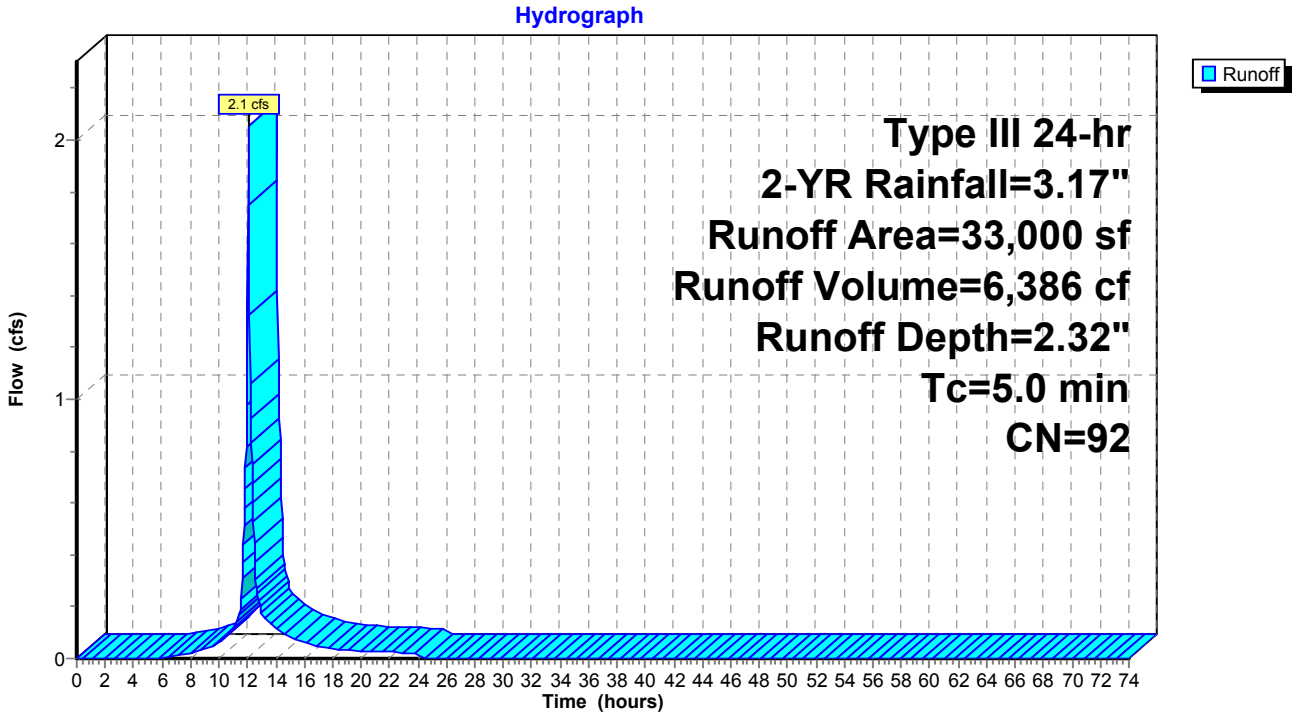
Runoff = 2.1 cfs @ 12.07 hrs, Volume= 6,386 cf, Depth= 2.32"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Type III 24-hr 2-YR Rainfall=3.17"

Area (sf)	CN	Description
29,550	98	Paved parking, HSG A
3,450	39	>75% Grass cover, Good, HSG A
33,000	92	Weighted Average
3,450		10.45% Pervious Area
29,550		89.55% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 5: Shoppers World Drive South



Summary for Pond 1P: Existing Pond - South

Inflow Area = 202,300 sf, 82.70% Impervious, Inflow Depth = 2.00" for 2-YR event
Inflow = 11.1 cfs @ 12.08 hrs, Volume= 33,765 cf
Outflow = 7.9 cfs @ 12.15 hrs, Volume= 33,765 cf, Atten= 29%, Lag= 4.6 min
Primary = 0.0 cfs @ 0.00 hrs, Volume= 0 cf
Secondary = 7.9 cfs @ 12.15 hrs, Volume= 33,765 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Starting Elev= 155.00' Surf.Area= 7,687 sf Storage= 16,436 cf
Peak Elev= 155.59' @ 12.15 hrs Surf.Area= 8,254 sf Storage= 21,128 cf (4,692 cf above start)

Plug-Flow detention time= 247.6 min calculated for 17,329 cf (51% of inflow)
Center-of-Mass det. time= 19.9 min (832.6 - 812.7)

Volume	Invert	Avail.Storage	Storage Description
#1	152.00'	49,544 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

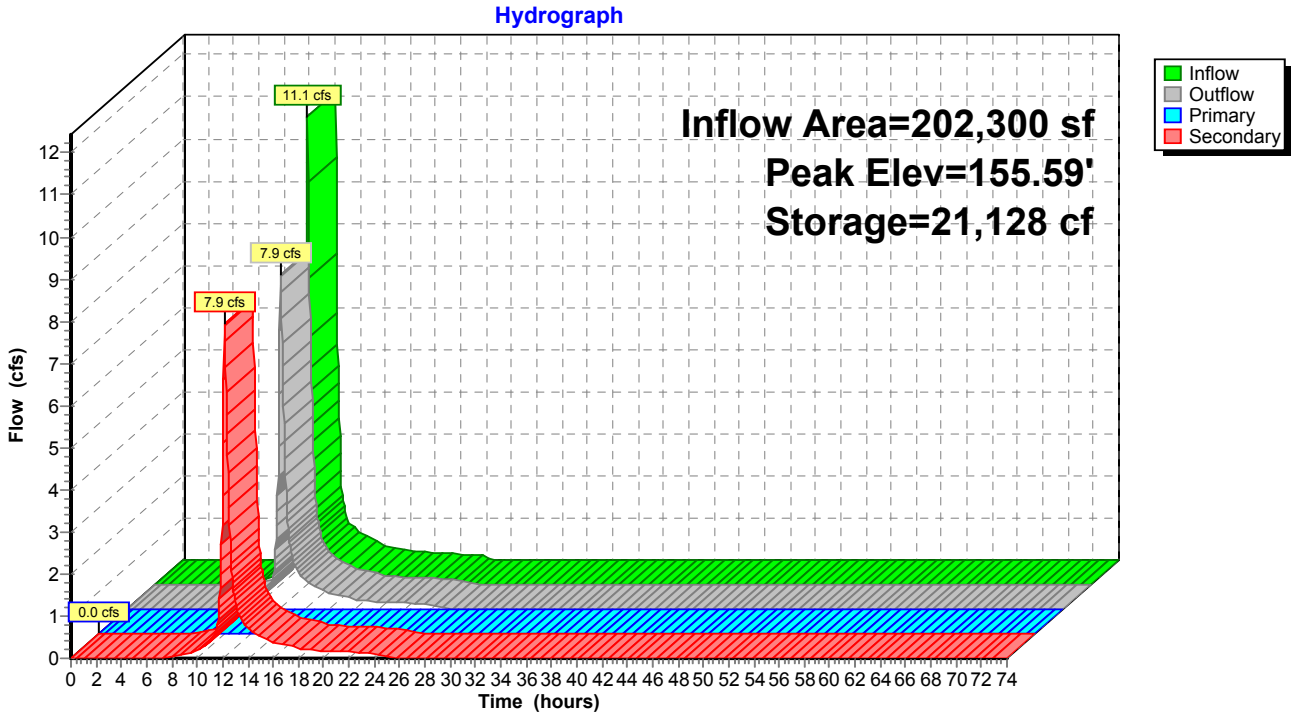
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
152.00	3,444	0	0
153.00	4,709	4,077	4,077
154.00	6,161	5,435	9,512
155.00	7,687	6,924	16,436
156.00	8,650	8,169	24,604
157.00	9,657	9,154	33,758
158.00	10,747	10,202	43,960
158.50	11,591	5,585	49,544

Device	Routing	Invert	Outlet Devices
#1	Primary	155.90'	**30.0" Round Culvert** L= 7.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 155.90' / 153.90' S= 0.2857 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 4.91 sf
#2	Device 1	154.10'	**4.0" Vert. Orifice** C= 0.600
#3	Device 1	155.30'	**45.0 deg Sharp-Crested Vee/Trap Weir** Cv= 2.56 (C= 3.20)
#4	Device 1	158.31'	**48.0" x 48.0" Horiz. Grate** C= 0.600 Limited to weir flow at low heads
#5	Secondary	155.00'	**6.5' long x 20.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=0.0 cfs @ 0.00 hrs HW=155.00' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Controls 0.0 cfs)
  └─**2=Orifice** (Controls 0.0 cfs)
  └─**3=Sharp-Crested Vee/Trap Weir** (Controls 0.0 cfs)
  └─**4=Grate** (Controls 0.0 cfs)

Secondary OutFlow Max=7.9 cfs @ 12.15 hrs HW=155.59' TW=0.00' (Dynamic Tailwater)
└─**5=Broad-Crested Rectangular Weir** (Weir Controls 7.9 cfs @ 2.07 fps)

Pond 1P: Existing Pond - South



Summary for Pond 2P: Existing Pond - North

Inflow Area = 34,200 sf, 71.20% Impervious, Inflow Depth = 1.45" for 2-YR event
Inflow = 1.4 cfs @ 12.08 hrs, Volume= 4,120 cf
Outflow = 0.2 cfs @ 12.71 hrs, Volume= 2,271 cf, Atten= 86%, Lag= 37.6 min
Primary = 0.2 cfs @ 12.71 hrs, Volume= 2,271 cf
Secondary = 0.0 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Peak Elev= 161.71' @ 12.71 hrs Surf.Area= 1,890 sf Storage= 2,050 cf

Plug-Flow detention time= 234.8 min calculated for 2,269 cf (55% of inflow)
Center-of-Mass det. time= 118.1 min (957.2 - 839.1)

Volume	Invert	Avail.Storage	Storage Description
#1	160.00'	7,631 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

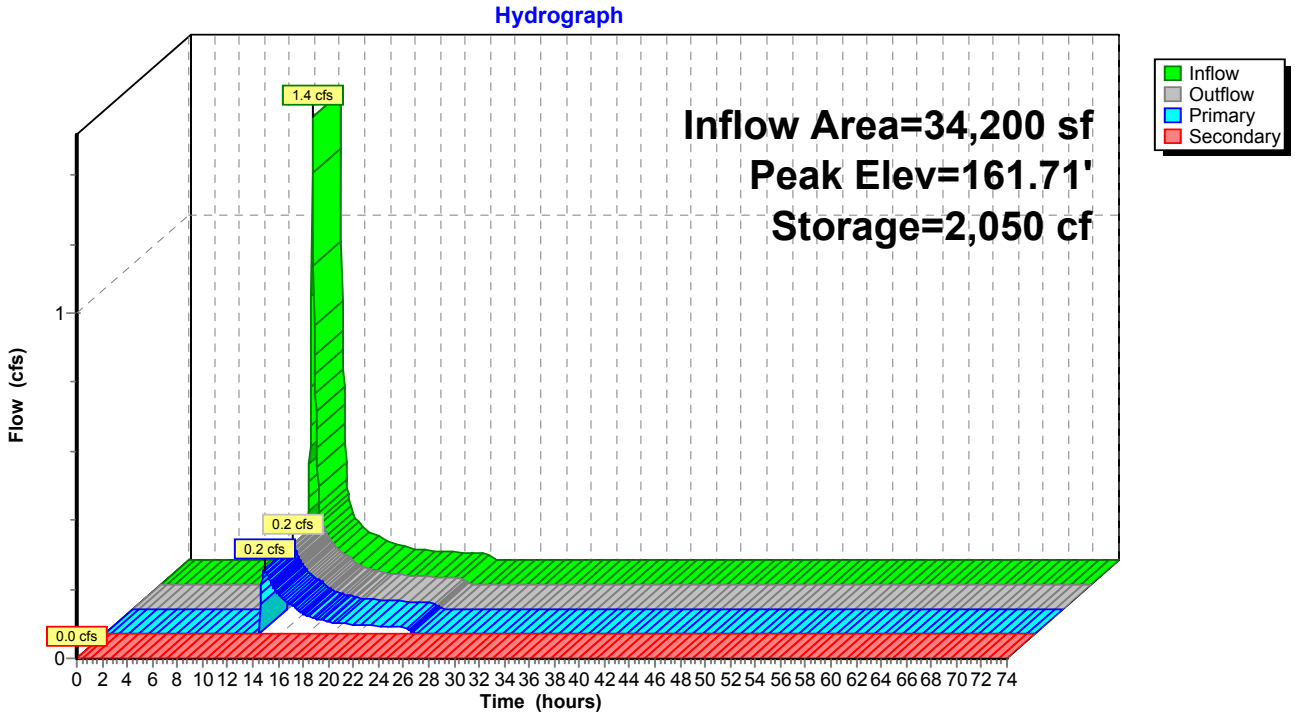
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
160.00	125	0	0
161.00	1,544	835	835
162.00	2,033	1,789	2,623
163.00	2,661	2,347	4,970
164.00	2,661	2,661	7,631

Device	Routing	Invert	Outlet Devices
#1	Primary	161.50'	**12.0" Round Culvert** L= 12.0' RCP, end-section conforming to fill, Ke= 0.500 Inlet / Outlet Invert= 161.50' / 161.20' S= 0.0250 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 0.79 sf
#2	Device 1	161.60'	**4.0' long x 2.00' rise Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#3	Device 1	163.60'	**48.0" W x 48.0" H Vert. Grate** C= 0.600
#4	Secondary	162.70'	**35.0' long x 4.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.38 2.54 2.69 2.68 2.67 2.67 2.65 2.66 2.66 2.68 2.72 2.73 2.76 2.79 2.88 3.07 3.32

Primary OutFlow Max=0.2 cfs @ 12.71 hrs HW=161.71' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 0.2 cfs @ 1.55 fps)
  └─**2=Sharp-Crested Rectangular Weir** (Passes 0.2 cfs of 0.5 cfs potential flow)
  └─**3=Grate** (Controls 0.0 cfs)

Secondary OutFlow Max=0.0 cfs @ 0.00 hrs HW=160.00' TW=0.00' (Dynamic Tailwater)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.0 cfs)

Pond 2P: Existing Pond - North

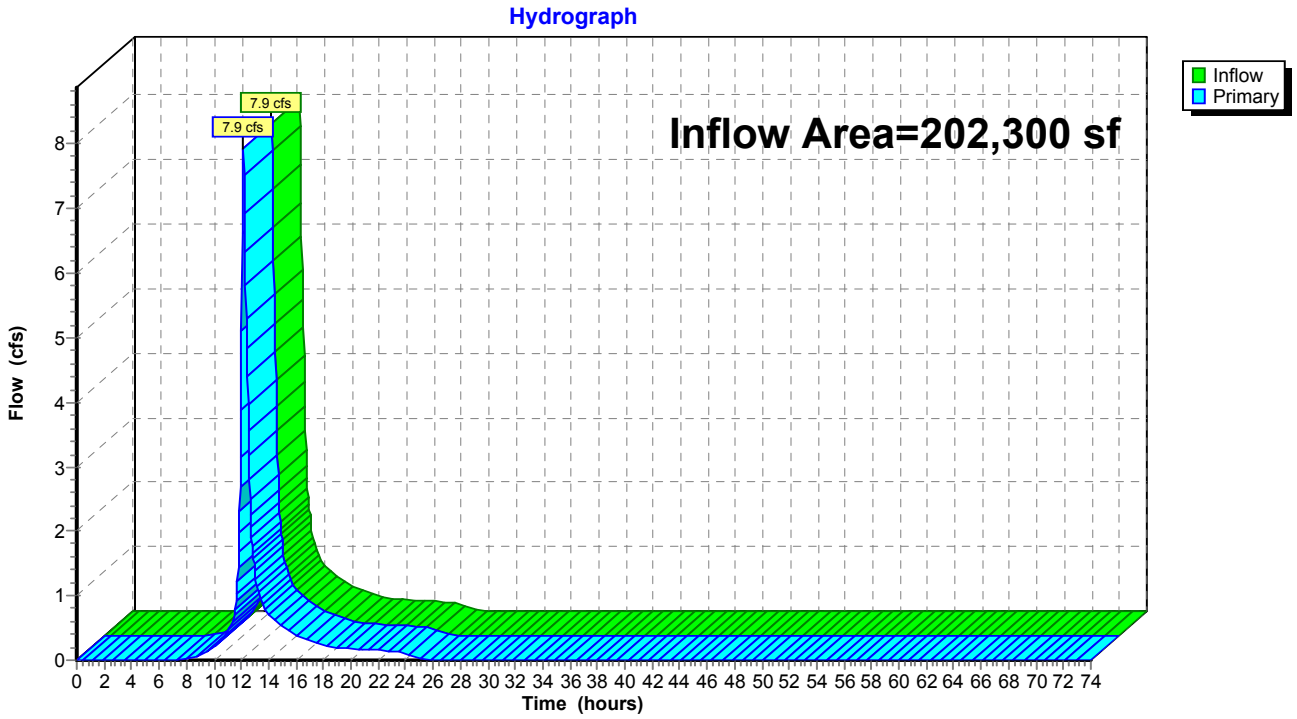


Summary for Link DP 1: South - Wetland

Inflow Area = 202,300 sf, 82.70% Impervious, Inflow Depth = 2.00" for 2-YR event
Inflow = 7.9 cfs @ 12.15 hrs, Volume= 33,765 cf
Primary = 7.9 cfs @ 12.15 hrs, Volume= 33,765 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs

Link DP 1: South - Wetland

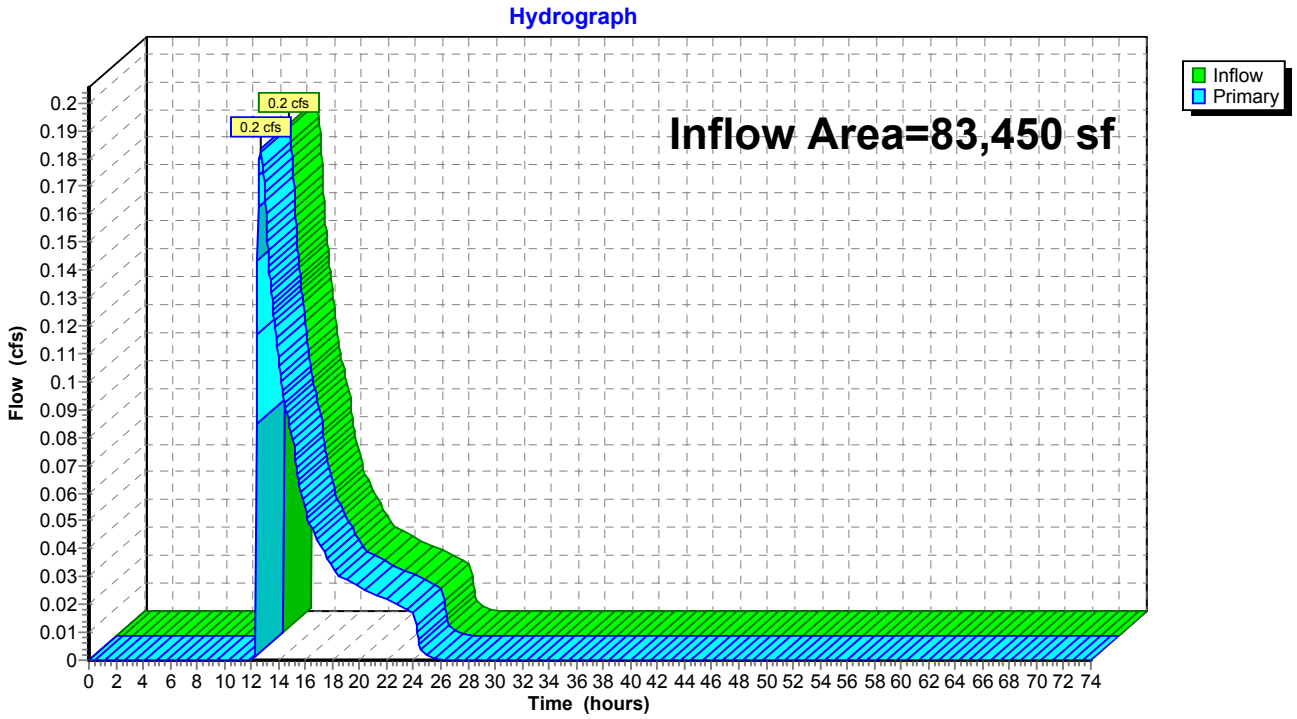


Summary for Link DP 2: North - Culvert

Inflow Area = 83,450 sf, 29.18% Impervious, Inflow Depth = 0.33" for 2-YR event
Inflow = 0.2 cfs @ 12.71 hrs, Volume= 2,271 cf
Primary = 0.2 cfs @ 12.71 hrs, Volume= 2,271 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs

Link DP 2: North - Culvert

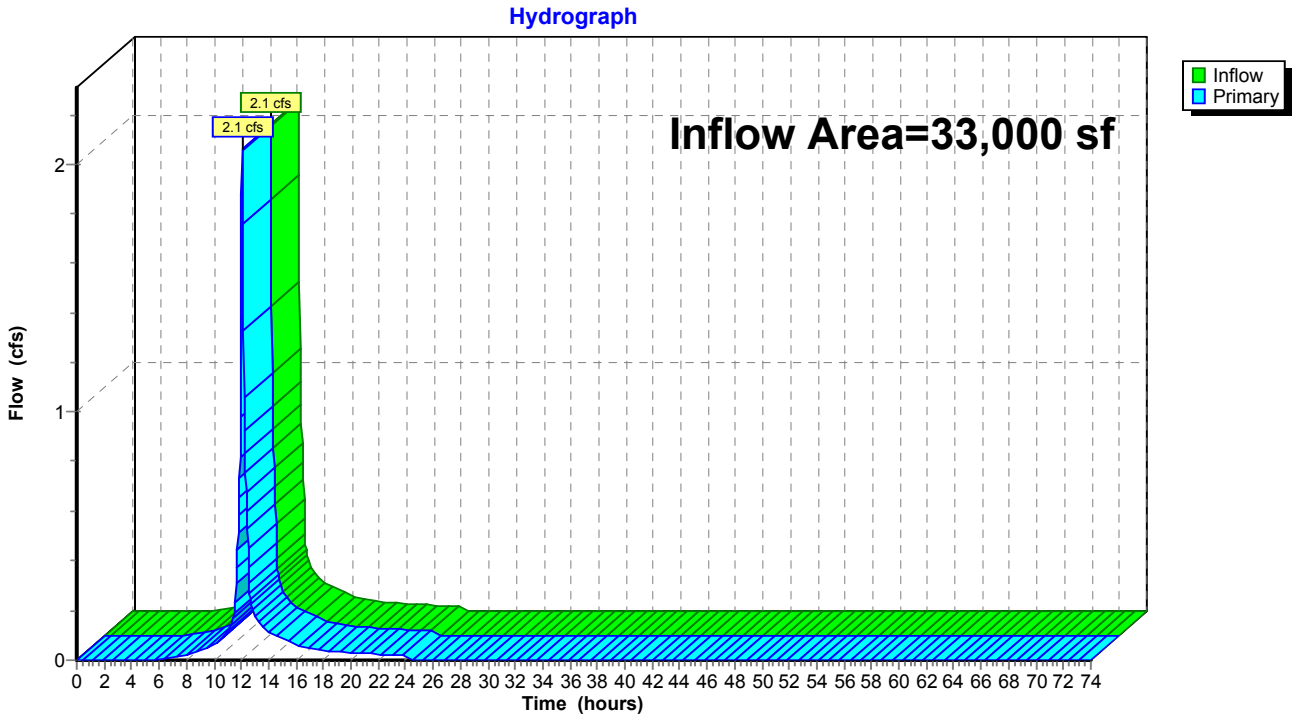


Summary for Link DP3: Shoppers World Drive

Inflow Area = 33,000 sf, 89.55% Impervious, Inflow Depth = 2.32" for 2-YR event
Inflow = 2.1 cfs @ 12.07 hrs, Volume= 6,386 cf
Primary = 2.1 cfs @ 12.07 hrs, Volume= 6,386 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs

Link DP3: Shoppers World Drive



10- Year-Storm-Event-Existing

Summary for Subcatchment 1: Parking Lot

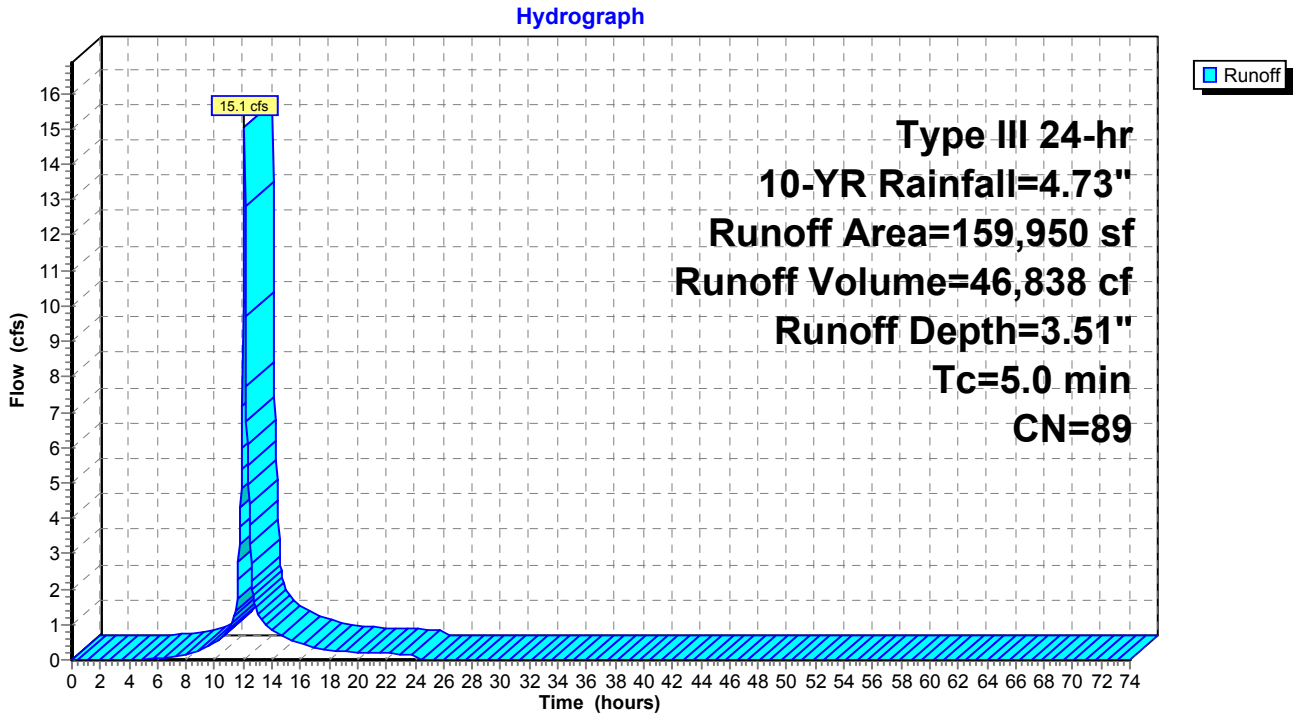
Runoff = 15.1 cfs @ 12.07 hrs, Volume= 46,838 cf, Depth= 3.51"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Type III 24-hr 10-YR Rainfall=4.73"

	Area (sf)	CN	Description
*	126,350	98	Paved parking
	22,700	39	>75% Grass cover, Good, HSG A
	3,850	80	>75% Grass cover, Good, HSG D
	6,900	98	Water Surface, HSG A
*	150	98	Water Surface, HSG D
	159,950	89	Weighted Average
	26,550		16.60% Pervious Area
	133,400		83.40% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 1: Parking Lot



Summary for Subcatchment 2: Parking Lot

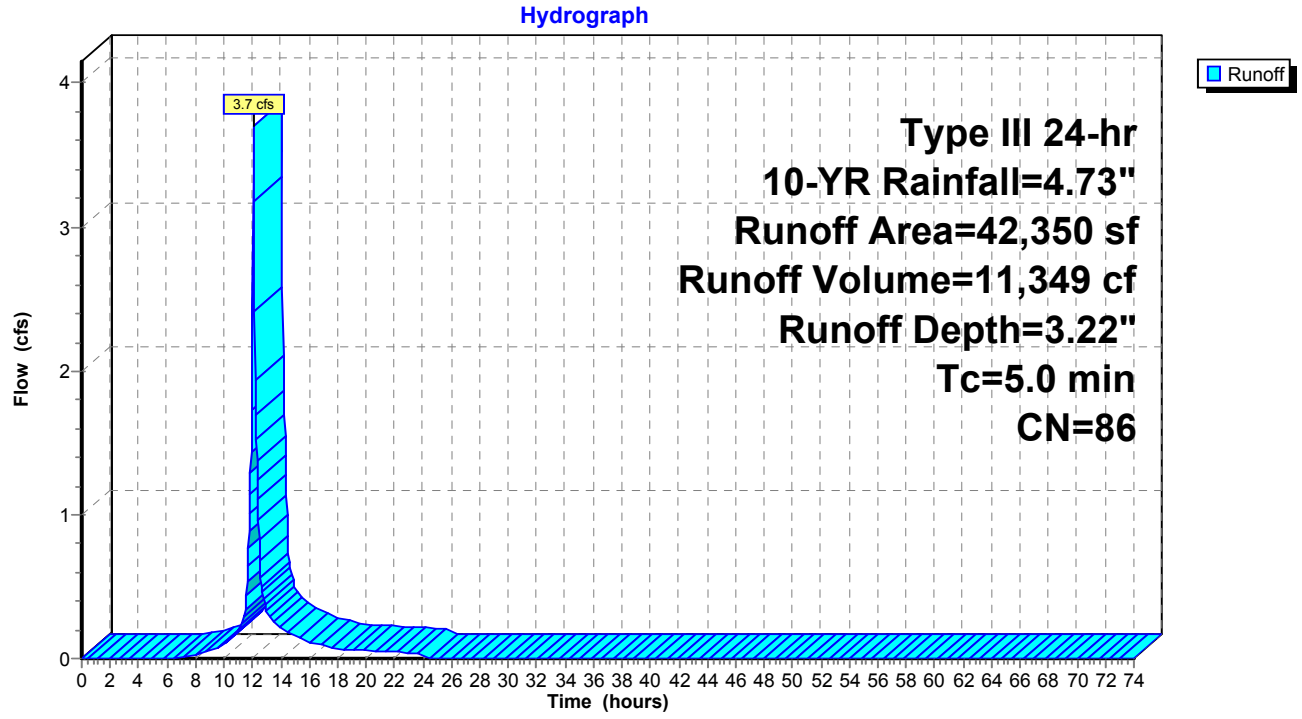
Runoff = 3.7 cfs @ 12.08 hrs, Volume= 11,349 cf, Depth= 3.22"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Type III 24-hr 10-YR Rainfall=4.73"

	Area (sf)	CN	Description
*	33,900	98	Paved parking
	8,450	39	>75% Grass cover, Good, HSG A
	42,350	86	Weighted Average
	8,450		19.95% Pervious Area
	33,900		80.05% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 2: Parking Lot



Summary for Subcatchment 3: Parking

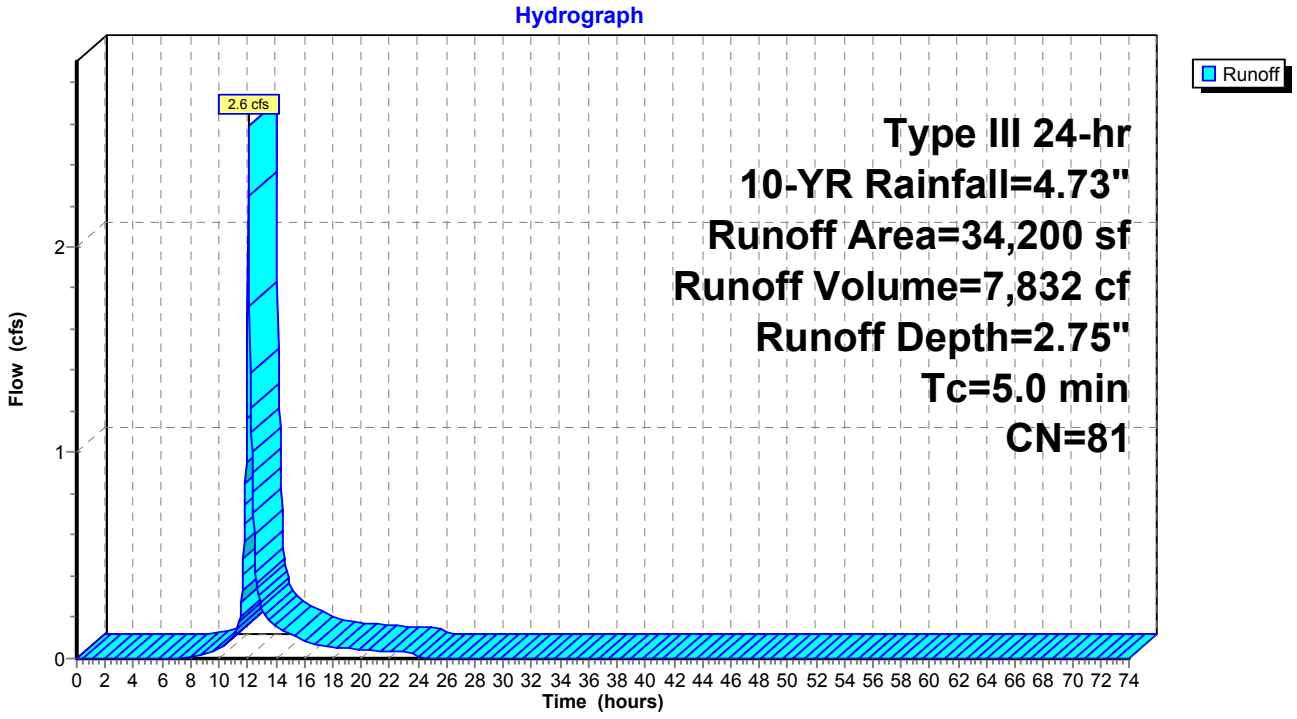
Runoff = 2.6 cfs @ 12.08 hrs, Volume= 7,832 cf, Depth= 2.75"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Type III 24-hr 10-YR Rainfall=4.73"

Area (sf)	CN	Description
24,350	98	Paved parking, HSG A
9,850	39	>75% Grass cover, Good, HSG A
34,200	81	Weighted Average
9,850		28.80% Pervious Area
24,350		71.20% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 3: Parking



Summary for Subcatchment 4: Northwest Grass/Woods

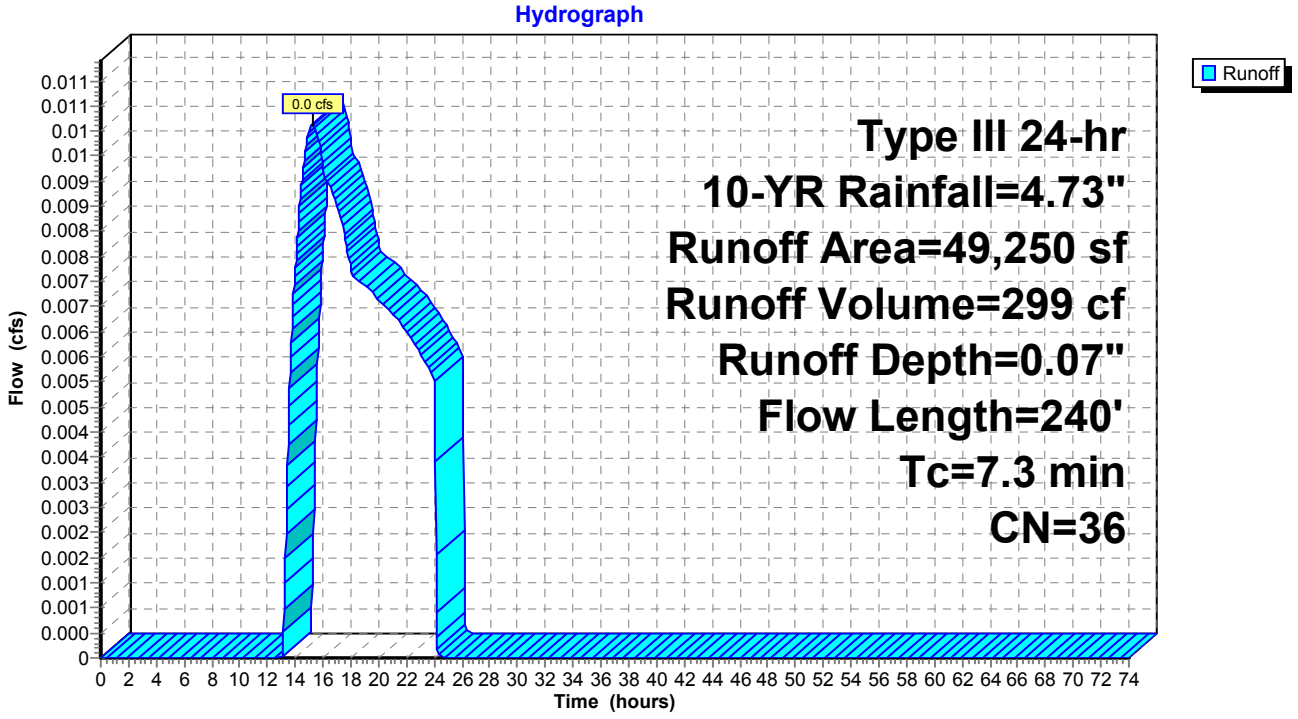
Runoff = 0.0 cfs @ 15.25 hrs, Volume= 299 cf, Depth= 0.07"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Type III 24-hr 10-YR Rainfall=4.73"

Area (sf)	CN	Description
30,900	39	>75% Grass cover, Good, HSG A
18,350	30	Woods, Good, HSG A
49,250	36	Weighted Average
49,250		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	20	0.3000	0.35		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.00"
3.3	30	0.0300	0.15		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.00"
2.4	114	0.0130	0.80		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.7	76	0.0130	1.71		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
7.3	240	Total			

Subcatchment 4: Northwest Grass/Woods



Summary for Subcatchment 5: Shoppers World Drive South

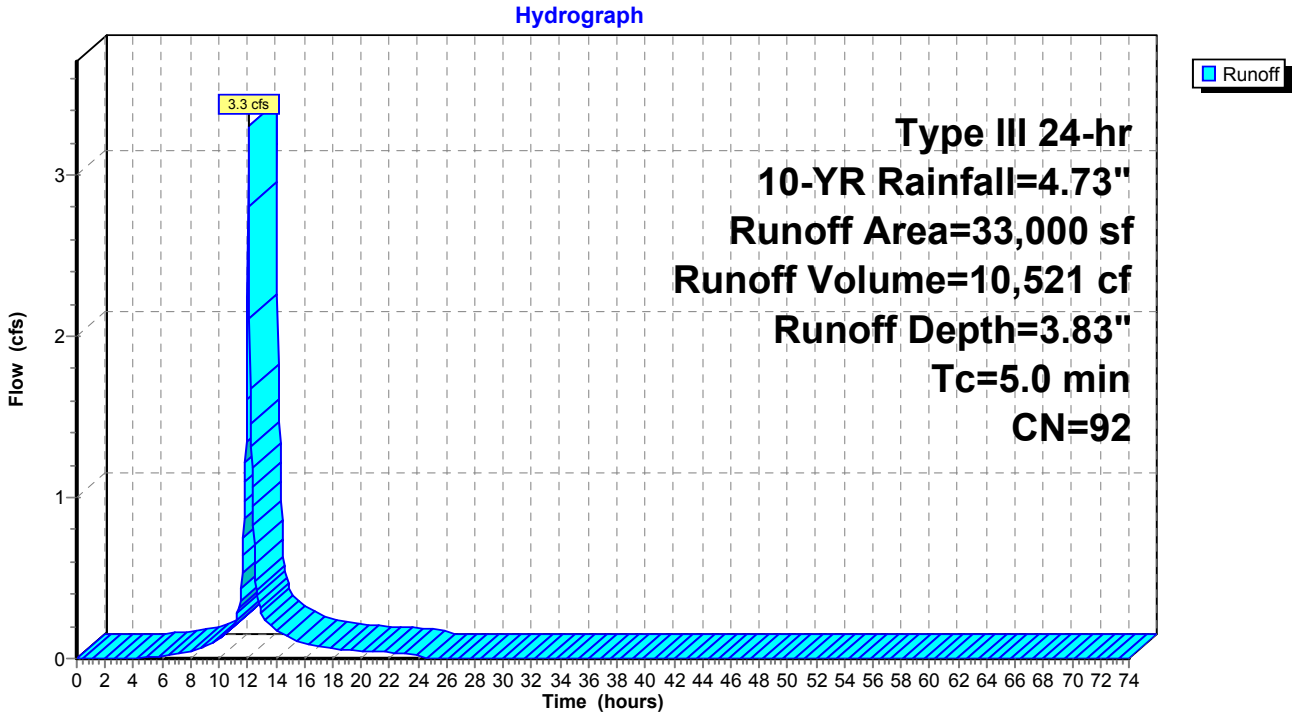
Runoff = 3.3 cfs @ 12.07 hrs, Volume= 10,521 cf, Depth= 3.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Type III 24-hr 10-YR Rainfall=4.73"

Area (sf)	CN	Description
29,550	98	Paved parking, HSG A
3,450	39	>75% Grass cover, Good, HSG A
33,000	92	Weighted Average
3,450		10.45% Pervious Area
29,550		89.55% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 5: Shoppers World Drive South



Summary for Pond 1P: Existing Pond - South

Inflow Area = 202,300 sf, 82.70% Impervious, Inflow Depth = 3.45" for 10-YR event
Inflow = 18.8 cfs @ 12.07 hrs, Volume= 58,188 cf
Outflow = 14.0 cfs @ 12.14 hrs, Volume= 58,188 cf, Atten= 25%, Lag= 4.1 min
Primary = 0.0 cfs @ 0.00 hrs, Volume= 0 cf
Secondary = 14.0 cfs @ 12.14 hrs, Volume= 58,188 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Starting Elev= 155.00' Surf.Area= 7,687 sf Storage= 16,436 cf
Peak Elev= 155.87' @ 12.14 hrs Surf.Area= 8,529 sf Storage= 23,527 cf (7,091 cf above start)

Plug-Flow detention time= 164.1 min calculated for 41,729 cf (72% of inflow)
Center-of-Mass det. time= 16.9 min (814.3 - 797.4)

Volume	Invert	Avail.Storage	Storage Description
#1	152.00'	49,544 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

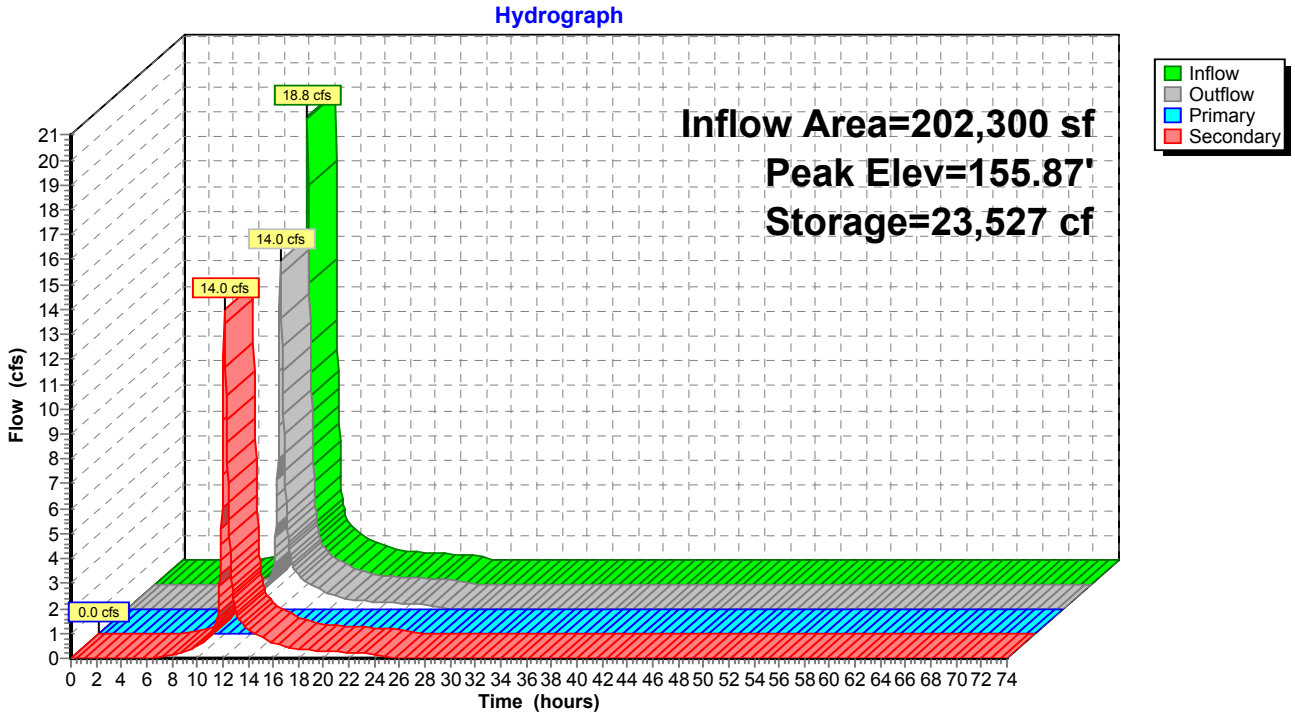
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
152.00	3,444	0	0
153.00	4,709	4,077	4,077
154.00	6,161	5,435	9,512
155.00	7,687	6,924	16,436
156.00	8,650	8,169	24,604
157.00	9,657	9,154	33,758
158.00	10,747	10,202	43,960
158.50	11,591	5,585	49,544

Device	Routing	Invert	Outlet Devices
#1	Primary	155.90'	**30.0" Round Culvert** L= 7.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 155.90' / 153.90' S= 0.2857 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 4.91 sf
#2	Device 1	154.10'	**4.0" Vert. Orifice** C= 0.600
#3	Device 1	155.30'	**45.0 deg Sharp-Crested Vee/Trap Weir** Cv= 2.56 (C= 3.20)
#4	Device 1	158.31'	**48.0" x 48.0" Horiz. Grate** C= 0.600 Limited to weir flow at low heads
#5	Secondary	155.00'	**6.5' long x 20.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=0.0 cfs @ 0.00 hrs HW=155.00' TW=0.00' (Dynamic Tailwater)
- **1=Culvert** (Controls 0.0 cfs)
  - **2=Orifice** (Controls 0.0 cfs)
  - **3=Sharp-Crested Vee/Trap Weir** (Controls 0.0 cfs)
  - **4=Grate** (Controls 0.0 cfs)

Secondary OutFlow Max=13.9 cfs @ 12.14 hrs HW=155.87' TW=0.00' (Dynamic Tailwater)
- **5=Broad-Crested Rectangular Weir** (Weir Controls 13.9 cfs @ 2.46 fps)

Pond 1P: Existing Pond - South



Summary for Pond 2P: Existing Pond - North

Inflow Area = 34,200 sf, 71.20% Impervious, Inflow Depth = 2.75" for 10-YR event
Inflow = 2.6 cfs @ 12.08 hrs, Volume= 7,832 cf
Outflow = 1.3 cfs @ 12.23 hrs, Volume= 5,983 cf, Atten= 51%, Lag= 9.3 min
Primary = 1.3 cfs @ 12.23 hrs, Volume= 5,983 cf
Secondary = 0.0 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Peak Elev= 162.09' @ 12.23 hrs Surf.Area= 2,090 sf Storage= 2,810 cf

Plug-Flow detention time= 143.6 min calculated for 5,980 cf (76% of inflow)
Center-of-Mass det. time= 59.1 min (879.6 - 820.5)

Volume	Invert	Avail.Storage	Storage Description
#1	160.00'	7,631 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

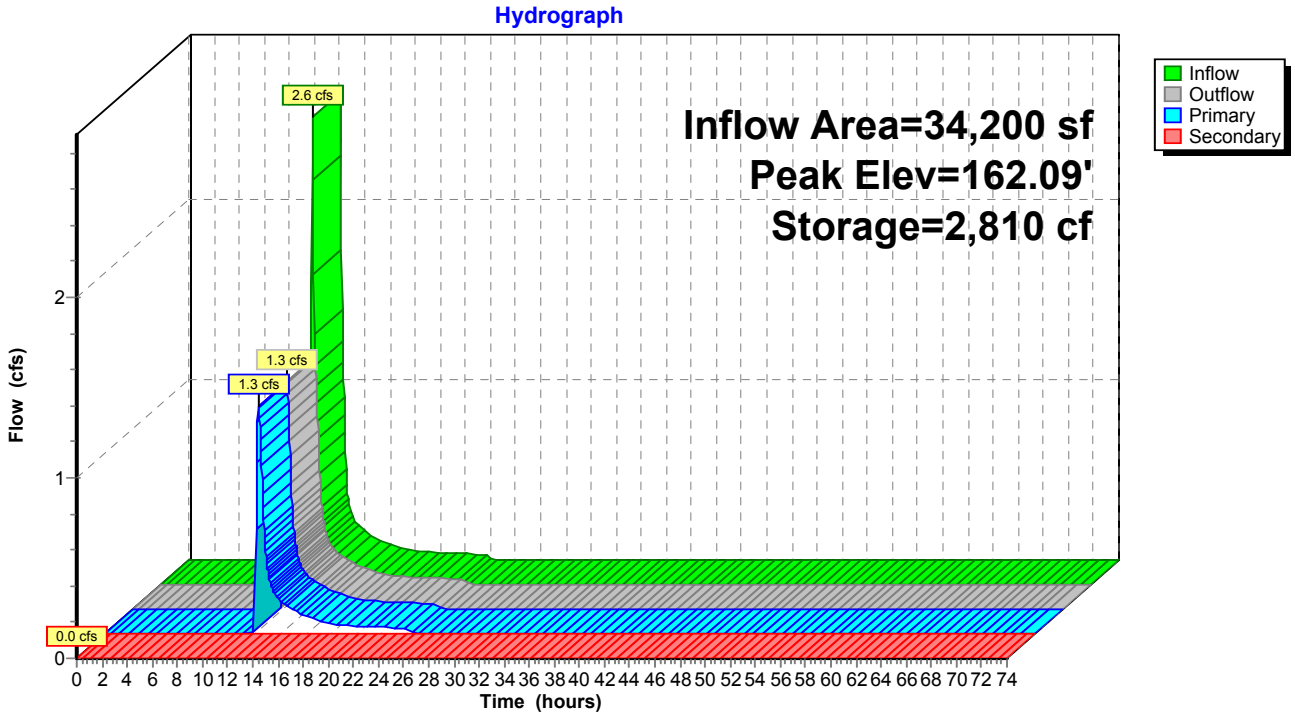
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
160.00	125	0	0
161.00	1,544	835	835
162.00	2,033	1,789	2,623
163.00	2,661	2,347	4,970
164.00	2,661	2,661	7,631

Device	Routing	Invert	Outlet Devices
#1	Primary	161.50'	**12.0" Round Culvert** L= 12.0' RCP, end-section conforming to fill, Ke= 0.500 Inlet / Outlet Invert= 161.50' / 161.20' S= 0.0250 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 0.79 sf
#2	Device 1	161.60'	**4.0' long x 2.00' rise Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#3	Device 1	163.60'	**48.0" W x 48.0" H Vert. Grate** C= 0.600
#4	Secondary	162.70'	**35.0' long x 4.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.38 2.54 2.69 2.68 2.67 2.67 2.65 2.66 2.66 2.68 2.72 2.73 2.76 2.79 2.88 3.07 3.32

Primary OutFlow Max=1.3 cfs @ 12.23 hrs HW=162.09' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 1.3 cfs @ 2.62 fps)
  └─**2=Sharp-Crested Rectangular Weir** (Passes 1.3 cfs of 4.4 cfs potential flow)
  └─**3=Grate** (Controls 0.0 cfs)

Secondary OutFlow Max=0.0 cfs @ 0.00 hrs HW=160.00' TW=0.00' (Dynamic Tailwater)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.0 cfs)

Pond 2P: Existing Pond - North

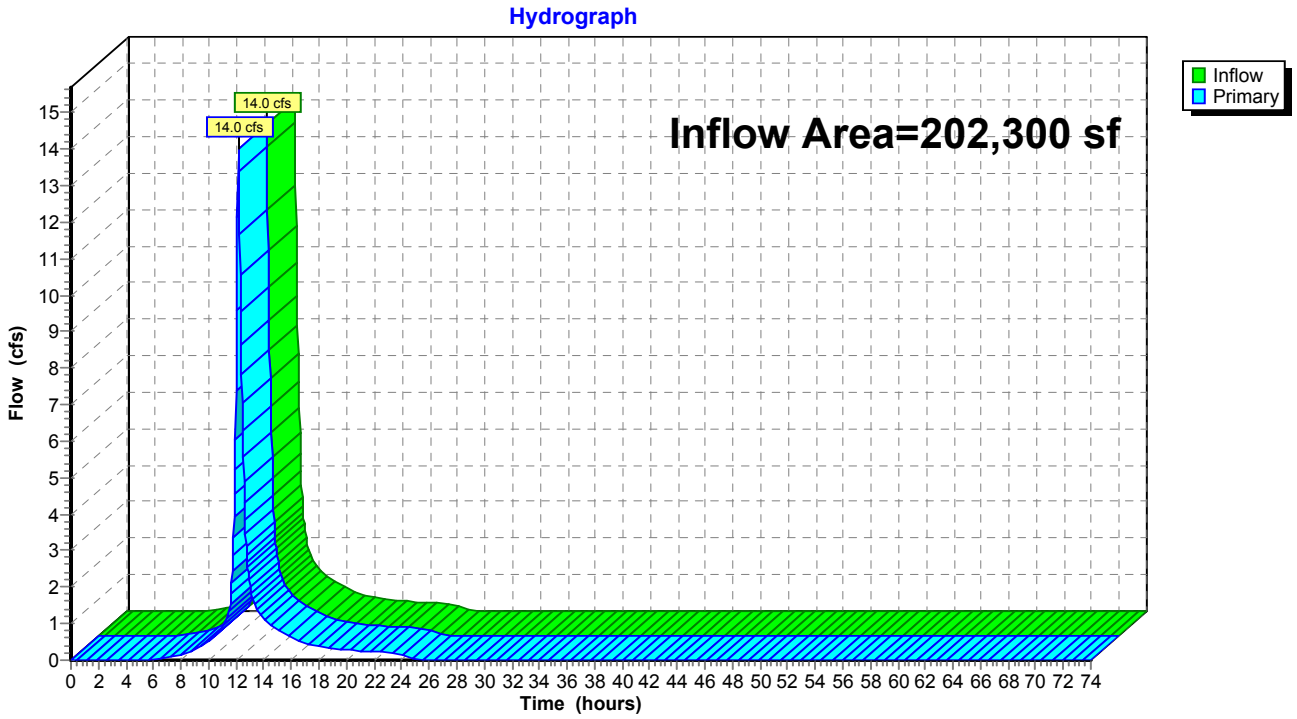


Summary for Link DP 1: South - Wetland

Inflow Area = 202,300 sf, 82.70% Impervious, Inflow Depth = 3.45" for 10-YR event
Inflow = 14.0 cfs @ 12.14 hrs, Volume= 58,188 cf
Primary = 14.0 cfs @ 12.14 hrs, Volume= 58,188 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs

Link DP 1: South - Wetland

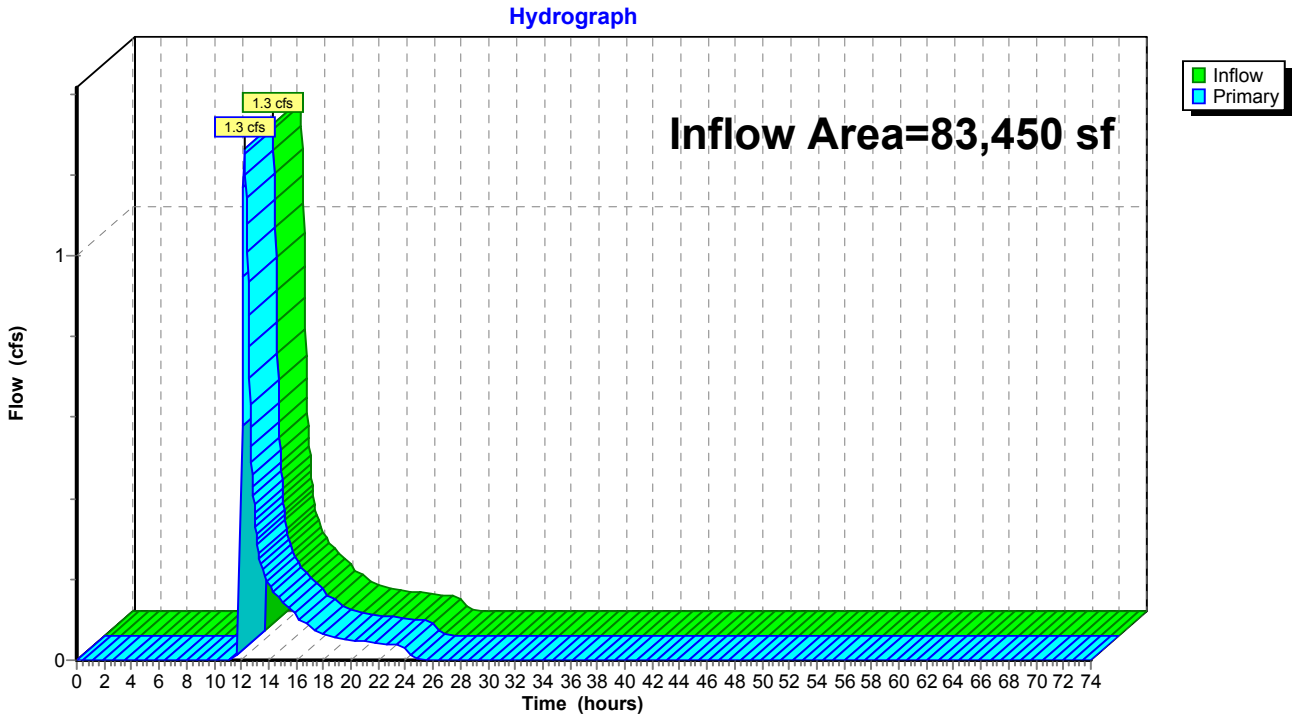


Summary for Link DP 2: North - Culvert

Inflow Area = 83,450 sf, 29.18% Impervious, Inflow Depth = 0.90" for 10-YR event
Inflow = 1.3 cfs @ 12.23 hrs, Volume= 6,282 cf
Primary = 1.3 cfs @ 12.23 hrs, Volume= 6,282 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs

Link DP 2: North - Culvert

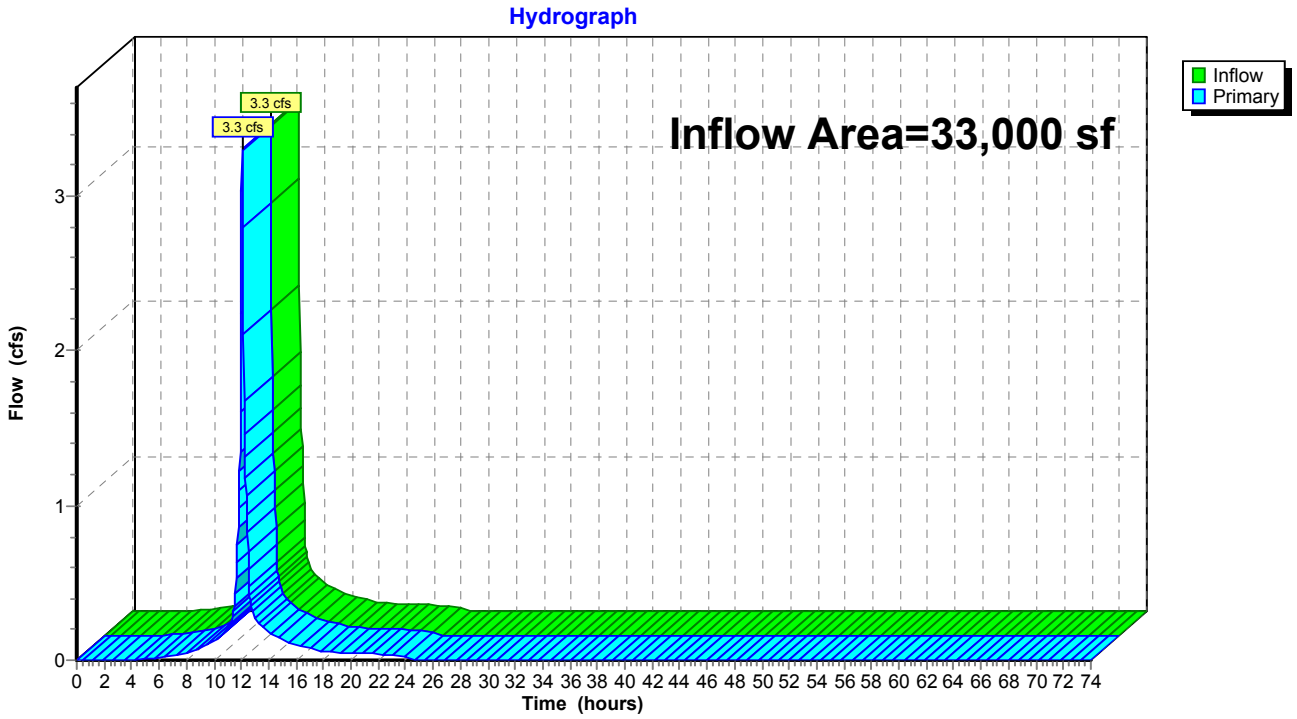


Summary for Link DP3: Shoppers World Drive

Inflow Area = 33,000 sf, 89.55% Impervious, Inflow Depth = 3.83" for 10-YR event
Inflow = 3.3 cfs @ 12.07 hrs, Volume= 10,521 cf
Primary = 3.3 cfs @ 12.07 hrs, Volume= 10,521 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs

Link DP3: Shoppers World Drive



25- Year-Storm-Event-Existing

Summary for Subcatchment 1: Parking Lot

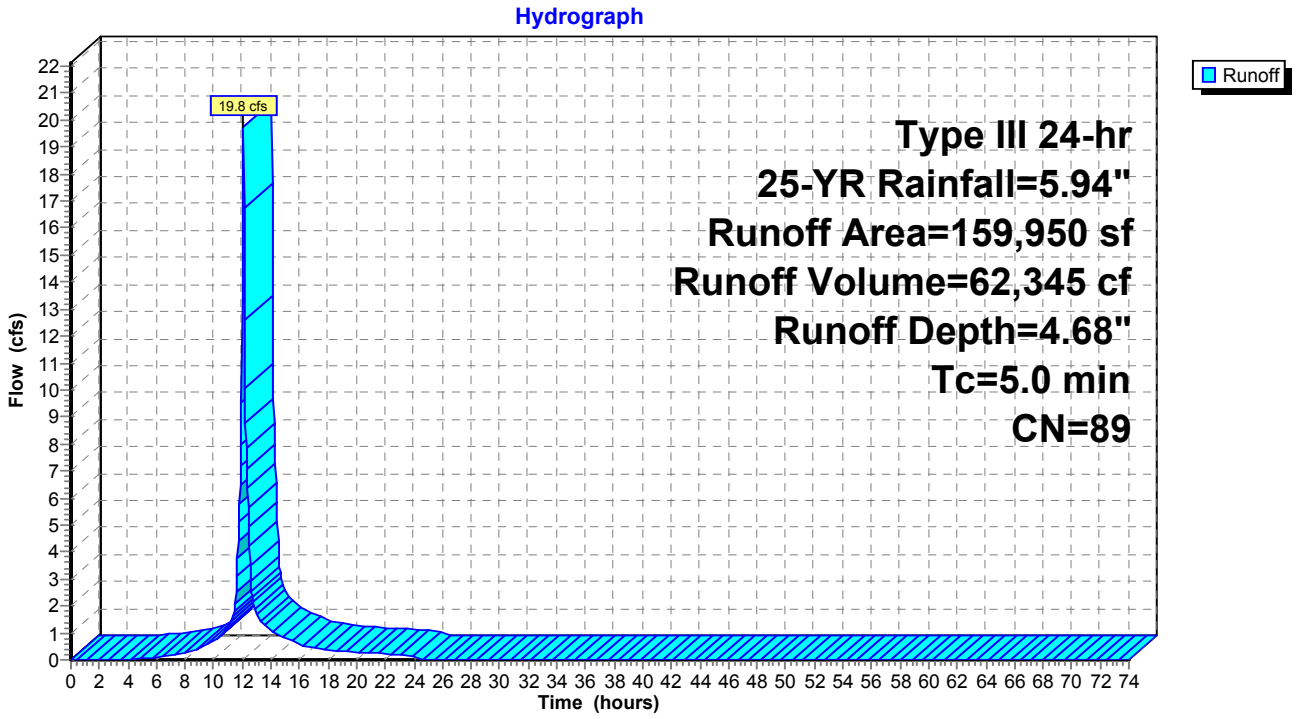
Runoff = 19.8 cfs @ 12.07 hrs, Volume= 62,345 cf, Depth= 4.68"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Type III 24-hr 25-YR Rainfall=5.94"

	Area (sf)	CN	Description
*	126,350	98	Paved parking
	22,700	39	>75% Grass cover, Good, HSG A
	3,850	80	>75% Grass cover, Good, HSG D
	6,900	98	Water Surface, HSG A
*	150	98	Water Surface, HSG D
	159,950	89	Weighted Average
	26,550		16.60% Pervious Area
	133,400		83.40% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 1: Parking Lot



Summary for Subcatchment 2: Parking Lot

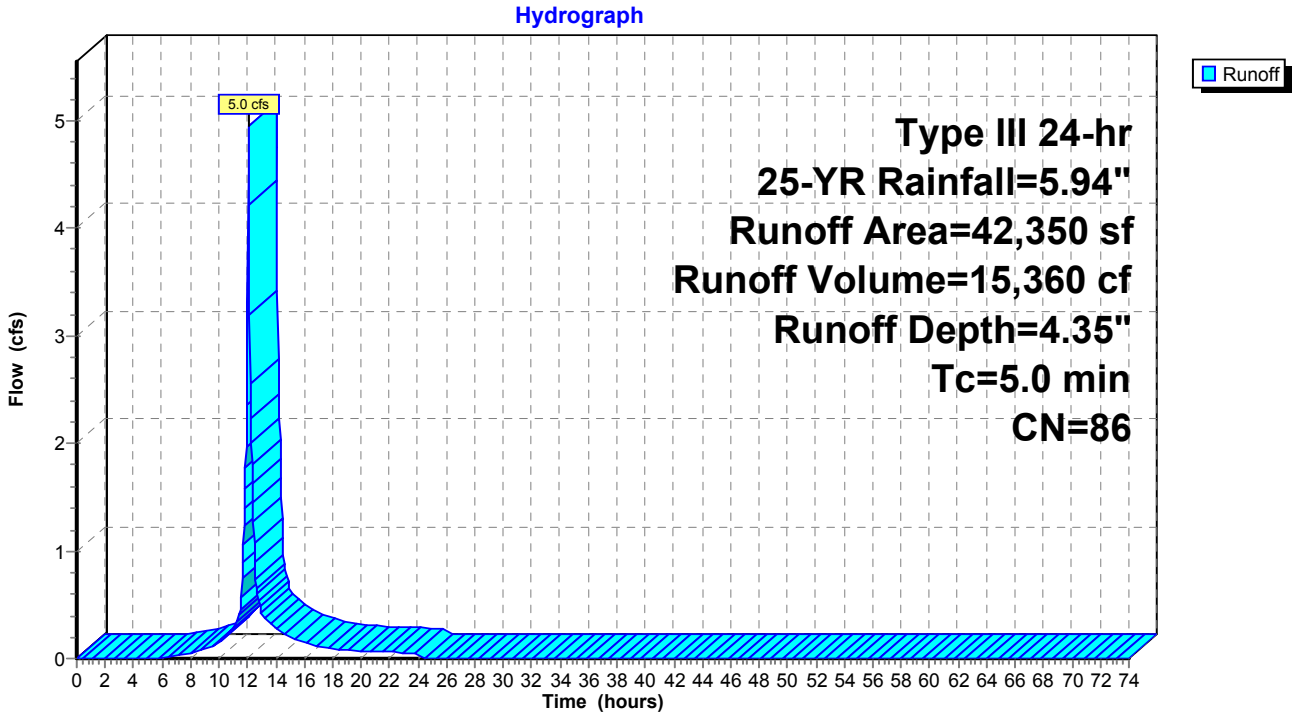
Runoff = 5.0 cfs @ 12.07 hrs, Volume= 15,360 cf, Depth= 4.35"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Type III 24-hr 25-YR Rainfall=5.94"

	Area (sf)	CN	Description
*	33,900	98	Paved parking
	8,450	39	>75% Grass cover, Good, HSG A
	42,350	86	Weighted Average
	8,450		19.95% Pervious Area
	33,900		80.05% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 2: Parking Lot



Summary for Subcatchment 3: Parking

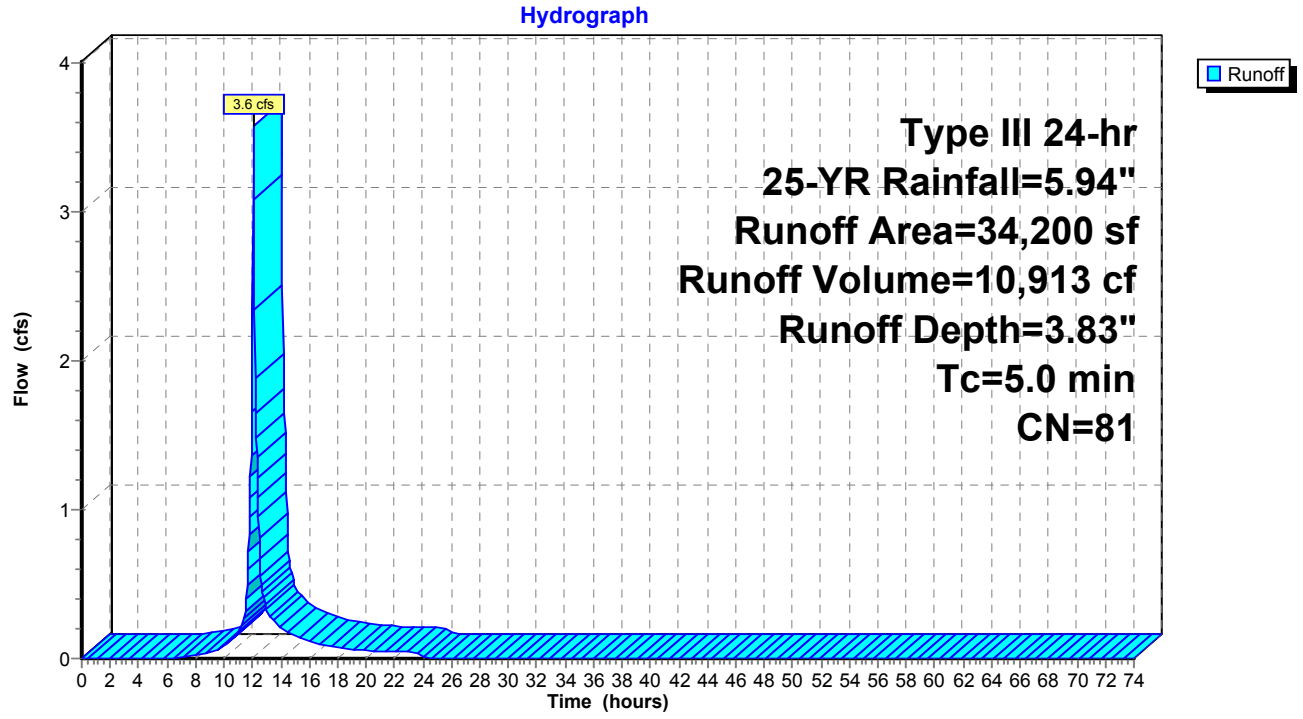
Runoff = 3.6 cfs @ 12.08 hrs, Volume= 10,913 cf, Depth= 3.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Type III 24-hr 25-YR Rainfall=5.94"

Area (sf)	CN	Description
24,350	98	Paved parking, HSG A
9,850	39	>75% Grass cover, Good, HSG A
34,200	81	Weighted Average
9,850		28.80% Pervious Area
24,350		71.20% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 3: Parking



Summary for Subcatchment 4: Northwest Grass/Woods

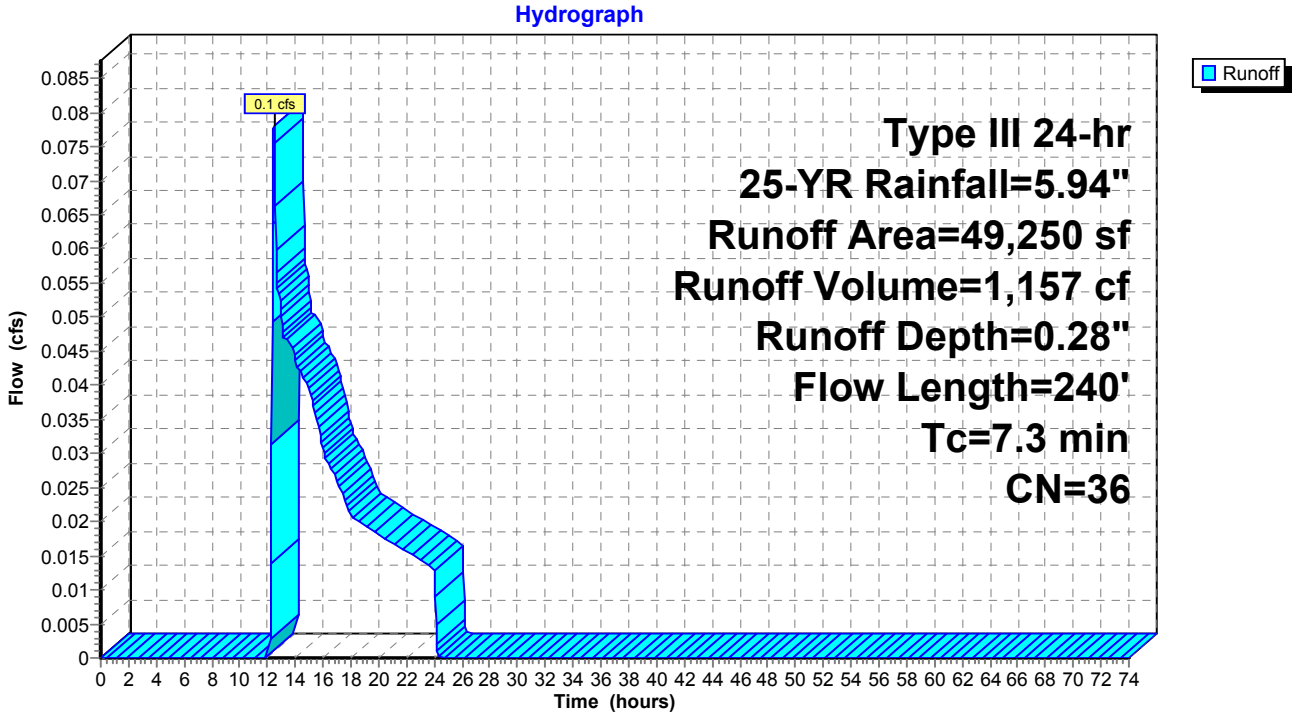
Runoff = 0.1 cfs @ 12.46 hrs, Volume= 1,157 cf, Depth= 0.28"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Type III 24-hr 25-YR Rainfall=5.94"

Area (sf)	CN	Description
30,900	39	>75% Grass cover, Good, HSG A
18,350	30	Woods, Good, HSG A
49,250	36	Weighted Average
49,250		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	20	0.3000	0.35		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.00"
3.3	30	0.0300	0.15		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.00"
2.4	114	0.0130	0.80		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.7	76	0.0130	1.71		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
7.3	240	Total			

Subcatchment 4: Northwest Grass/Woods



Summary for Subcatchment 5: Shoppers World Drive South

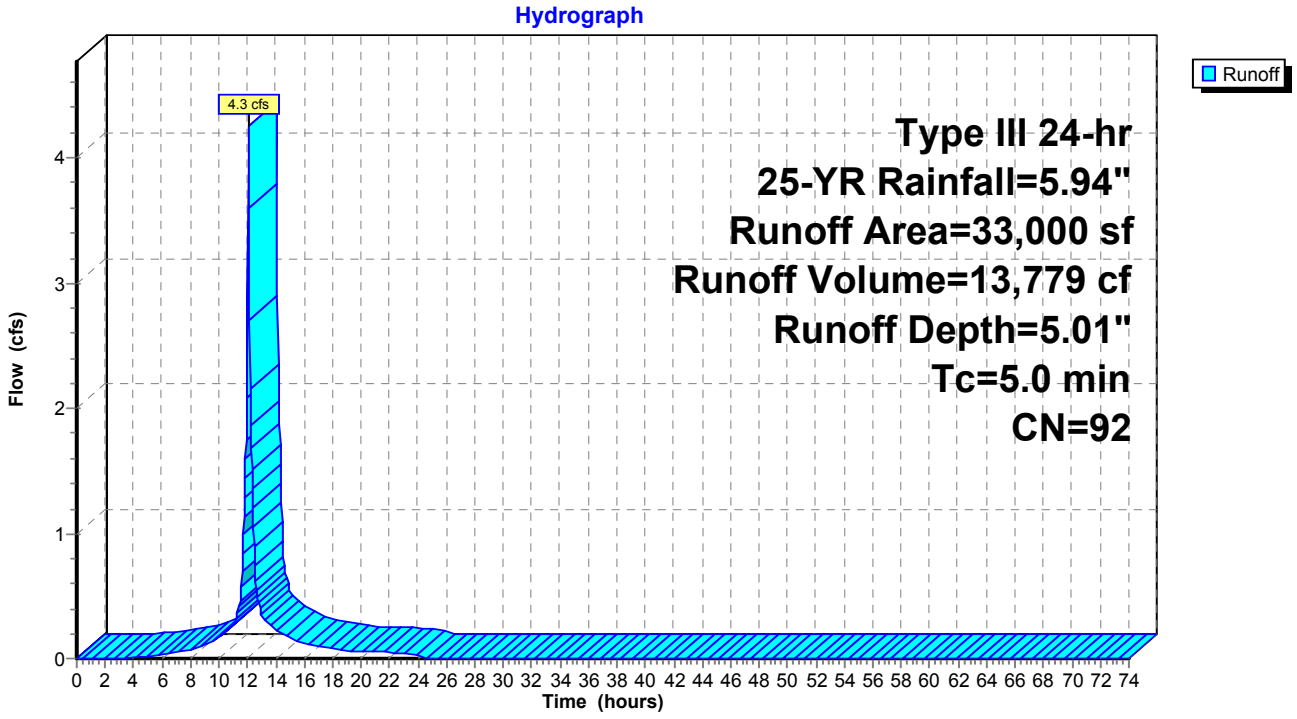
Runoff = 4.3 cfs @ 12.07 hrs, Volume= 13,779 cf, Depth= 5.01"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Type III 24-hr 25-YR Rainfall=5.94"

Area (sf)	CN	Description
29,550	98	Paved parking, HSG A
3,450	39	>75% Grass cover, Good, HSG A
33,000	92	Weighted Average
3,450		10.45% Pervious Area
29,550		89.55% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 5: Shoppers World Drive South



Summary for Pond 1P: Existing Pond - South

Inflow Area = 202,300 sf, 82.70% Impervious, Inflow Depth = 4.61" for 25-YR event
Inflow = 24.7 cfs @ 12.07 hrs, Volume= 77,705 cf
Outflow = 19.2 cfs @ 12.14 hrs, Volume= 77,705 cf, Atten= 22%, Lag= 3.7 min
Primary = 0.2 cfs @ 12.14 hrs, Volume= 69 cf
Secondary = 19.0 cfs @ 12.14 hrs, Volume= 77,636 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Starting Elev= 155.00' Surf.Area= 7,687 sf Storage= 16,436 cf
Peak Elev= 156.07' @ 12.14 hrs Surf.Area= 8,723 sf Storage= 25,233 cf (8,798 cf above start)

Plug-Flow detention time= 139.4 min calculated for 61,237 cf (79% of inflow)
Center-of-Mass det. time= 15.6 min (805.0 - 789.5)

Volume	Invert	Avail.Storage	Storage Description
#1	152.00'	49,544 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

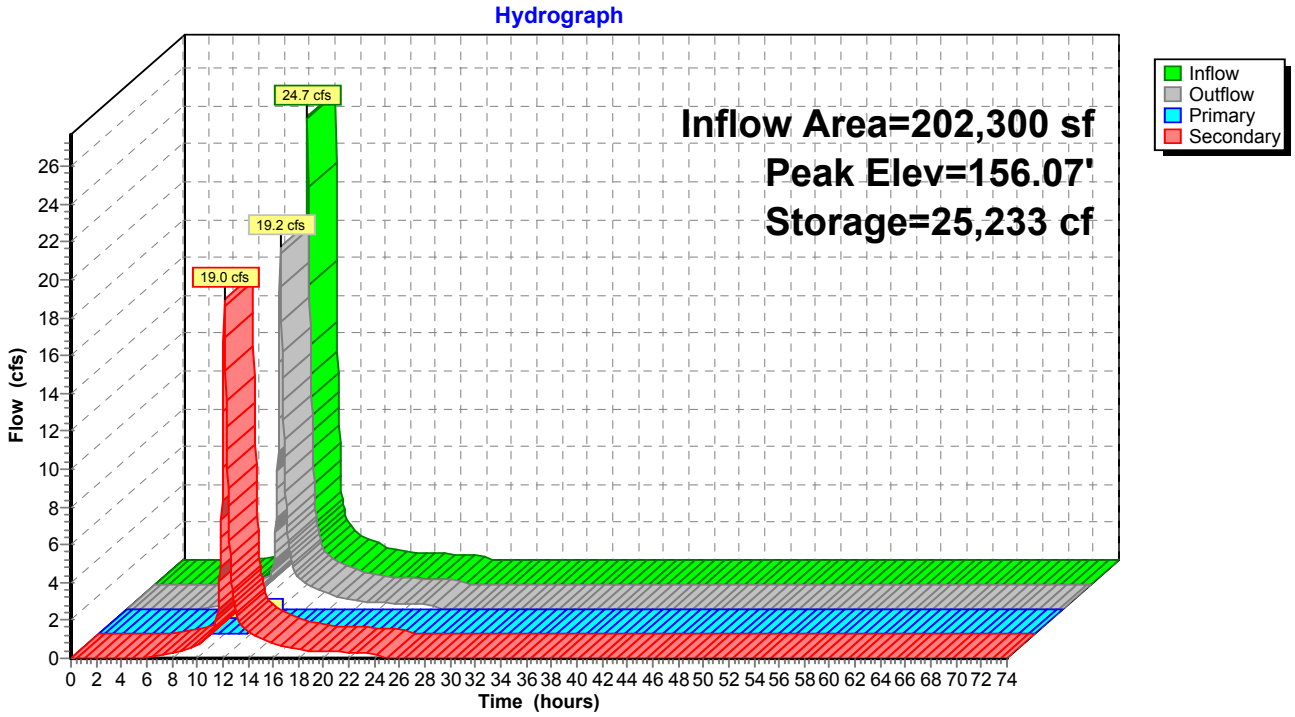
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
152.00	3,444	0	0
153.00	4,709	4,077	4,077
154.00	6,161	5,435	9,512
155.00	7,687	6,924	16,436
156.00	8,650	8,169	24,604
157.00	9,657	9,154	33,758
158.00	10,747	10,202	43,960
158.50	11,591	5,585	49,544

Device	Routing	Invert	Outlet Devices
#1	Primary	155.90'	**30.0" Round Culvert** L= 7.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 155.90' / 153.90' S= 0.2857 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 4.91 sf
#2	Device 1	154.10'	**4.0" Vert. Orifice** C= 0.600
#3	Device 1	155.30'	**45.0 deg Sharp-Crested Vee/Trap Weir** Cv= 2.56 (C= 3.20)
#4	Device 1	158.31'	**48.0" x 48.0" Horiz. Grate** C= 0.600 Limited to weir flow at low heads
#5	Secondary	155.00'	**6.5' long x 20.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=0.2 cfs @ 12.14 hrs HW=156.06' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 0.2 cfs @ 1.37 fps)
  └─**2=Orifice** (Passes < 0.2 cfs potential flow)
  └─**3=Sharp-Crested Vee/Trap Weir** (Passes < 0.4 cfs potential flow)
  └─**4=Grate** (Controls 0.0 cfs)

Secondary OutFlow Max=18.7 cfs @ 12.14 hrs HW=156.06' TW=0.00' (Dynamic Tailwater)
└─**5=Broad-Crested Rectangular Weir** (Weir Controls 18.7 cfs @ 2.71 fps)

Pond 1P: Existing Pond - South



Summary for Pond 2P: Existing Pond - North

Inflow Area = 34,200 sf, 71.20% Impervious, Inflow Depth = 3.83" for 25-YR event
Inflow = 3.6 cfs @ 12.08 hrs, Volume= 10,913 cf
Outflow = 2.2 cfs @ 12.17 hrs, Volume= 9,064 cf, Atten= 37%, Lag= 5.8 min
Primary = 2.2 cfs @ 12.17 hrs, Volume= 9,064 cf
Secondary = 0.0 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Peak Elev= 162.35' @ 12.17 hrs Surf.Area= 2,255 sf Storage= 3,381 cf

Plug-Flow detention time= 118.0 min calculated for 9,064 cf (83% of inflow)
Center-of-Mass det. time= 48.2 min (859.2 - 811.0)

Volume	Invert	Avail.Storage	Storage Description
#1	160.00'	7,631 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

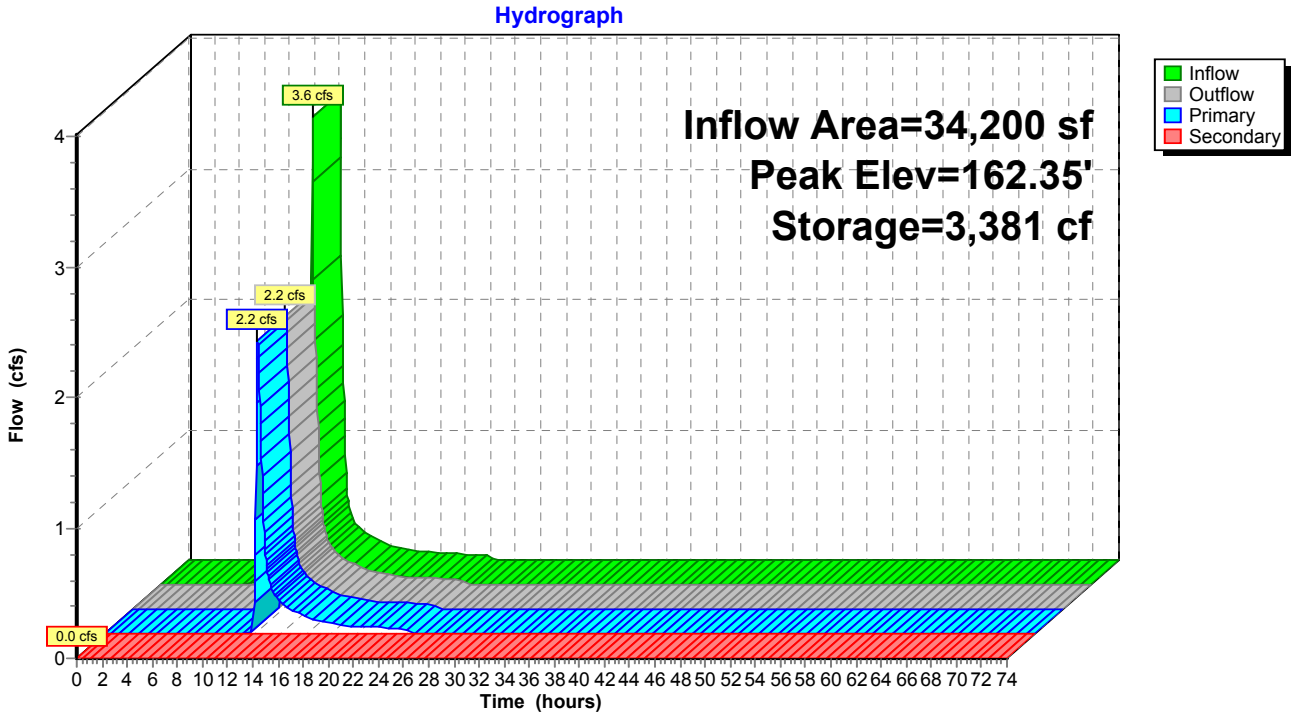
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
160.00	125	0	0
161.00	1,544	835	835
162.00	2,033	1,789	2,623
163.00	2,661	2,347	4,970
164.00	2,661	2,661	7,631

Device	Routing	Invert	Outlet Devices
#1	Primary	161.50'	**12.0" Round Culvert** L= 12.0' RCP, end-section conforming to fill, Ke= 0.500 Inlet / Outlet Invert= 161.50' / 161.20' S= 0.0250 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 0.79 sf
#2	Device 1	161.60'	**4.0' long x 2.00' rise Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#3	Device 1	163.60'	**48.0" W x 48.0" H Vert. Grate** C= 0.600
#4	Secondary	162.70'	**35.0' long x 4.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.38 2.54 2.69 2.68 2.67 2.67 2.65 2.66 2.66 2.68 2.72 2.73 2.76 2.79 2.88 3.07 3.32

Primary OutFlow Max=2.2 cfs @ 12.17 hrs HW=162.35' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 2.2 cfs @ 3.14 fps)
  └─**2=Sharp-Crested Rectangular Weir** (Passes 2.2 cfs of 8.2 cfs potential flow)
  └─**3=Grate** (Controls 0.0 cfs)

Secondary OutFlow Max=0.0 cfs @ 0.00 hrs HW=160.00' TW=0.00' (Dynamic Tailwater)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.0 cfs)

Pond 2P: Existing Pond - North

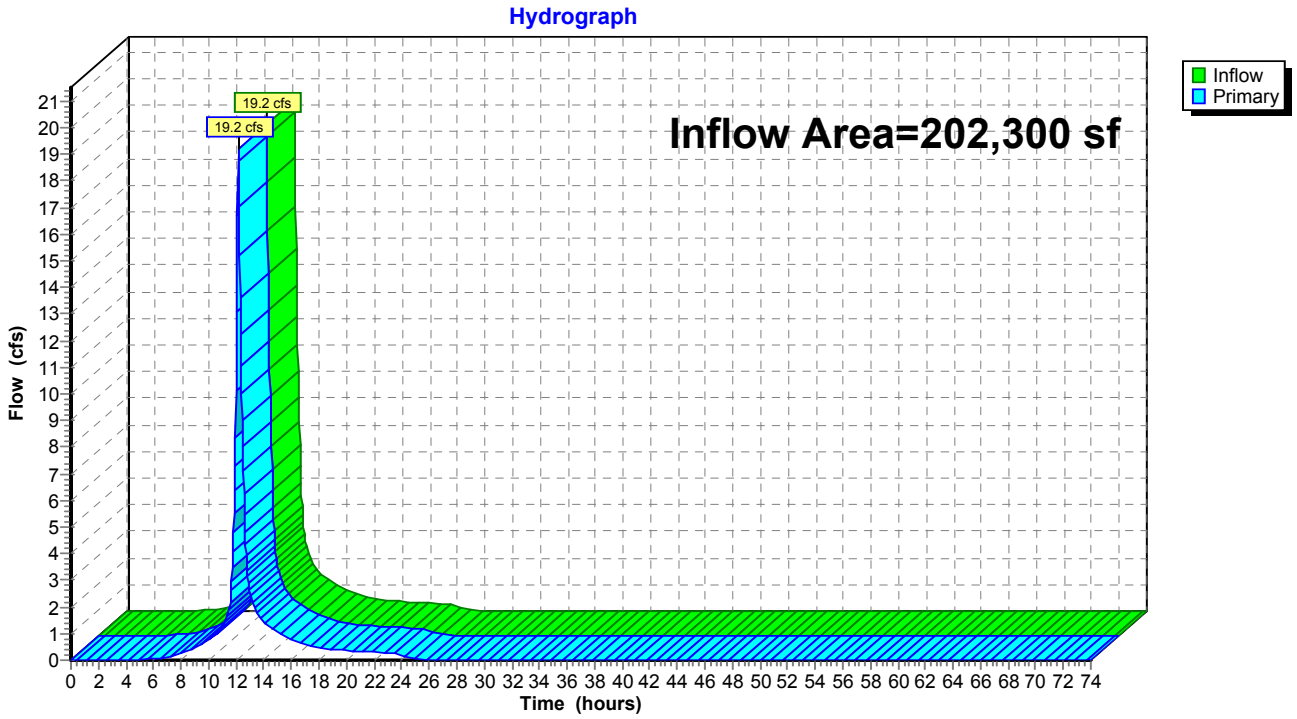


Summary for Link DP 1: South - Wetland

Inflow Area = 202,300 sf, 82.70% Impervious, Inflow Depth = 4.61" for 25-YR event
Inflow = 19.2 cfs @ 12.14 hrs, Volume= 77,705 cf
Primary = 19.2 cfs @ 12.14 hrs, Volume= 77,705 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs

Link DP 1: South - Wetland

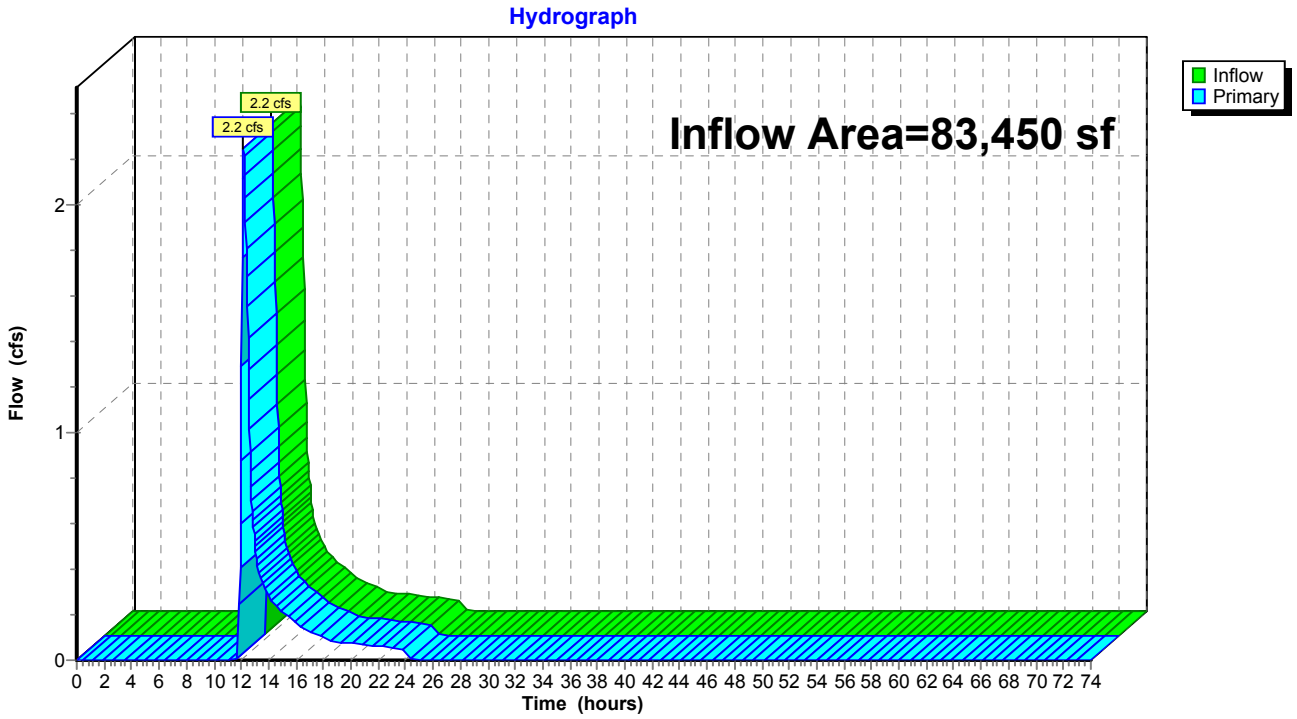


Summary for Link DP 2: North - Culvert

Inflow Area = 83,450 sf, 29.18% Impervious, Inflow Depth = 1.47" for 25-YR event
Inflow = 2.2 cfs @ 12.17 hrs, Volume= 10,221 cf
Primary = 2.2 cfs @ 12.17 hrs, Volume= 10,221 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs

Link DP 2: North - Culvert

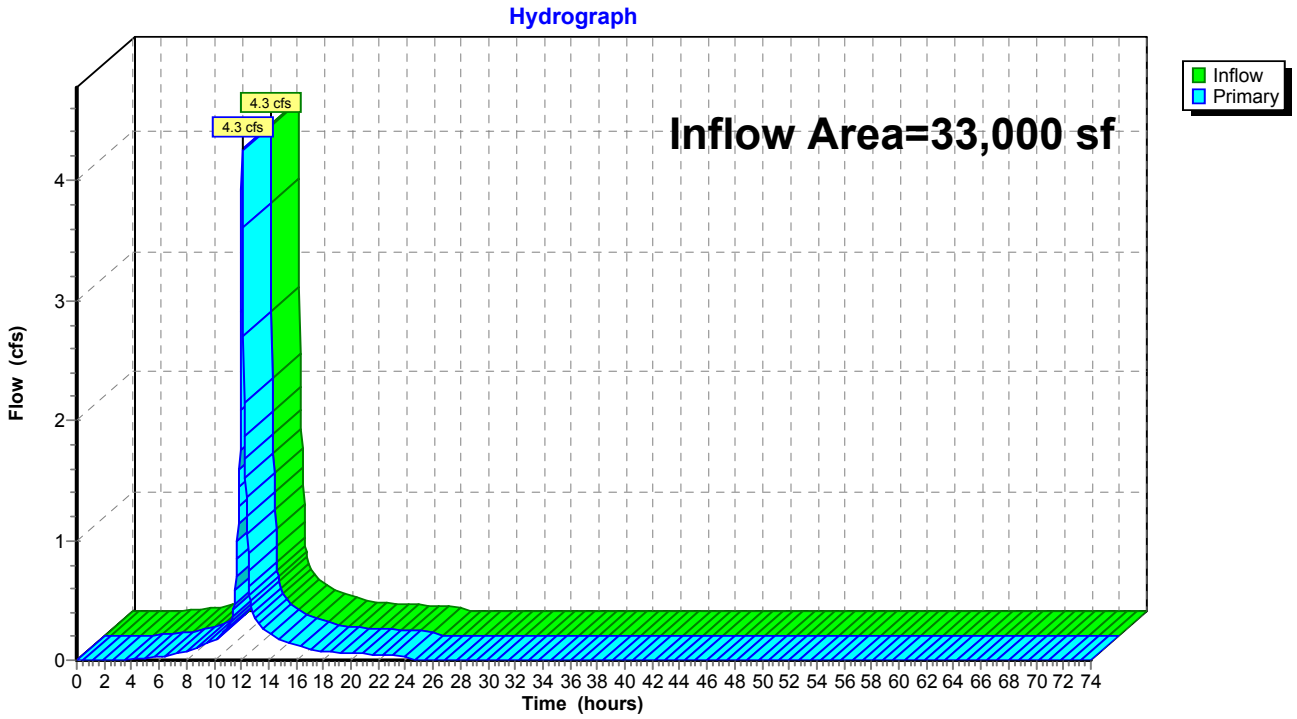


Summary for Link DP3: Shoppers World Drive

Inflow Area = 33,000 sf, 89.55% Impervious, Inflow Depth = 5.01" for 25-YR event
Inflow = 4.3 cfs @ 12.07 hrs, Volume= 13,779 cf
Primary = 4.3 cfs @ 12.07 hrs, Volume= 13,779 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs

Link DP3: Shoppers World Drive



100- Year-Storm-Event-Existing

Summary for Subcatchment 1: Parking Lot

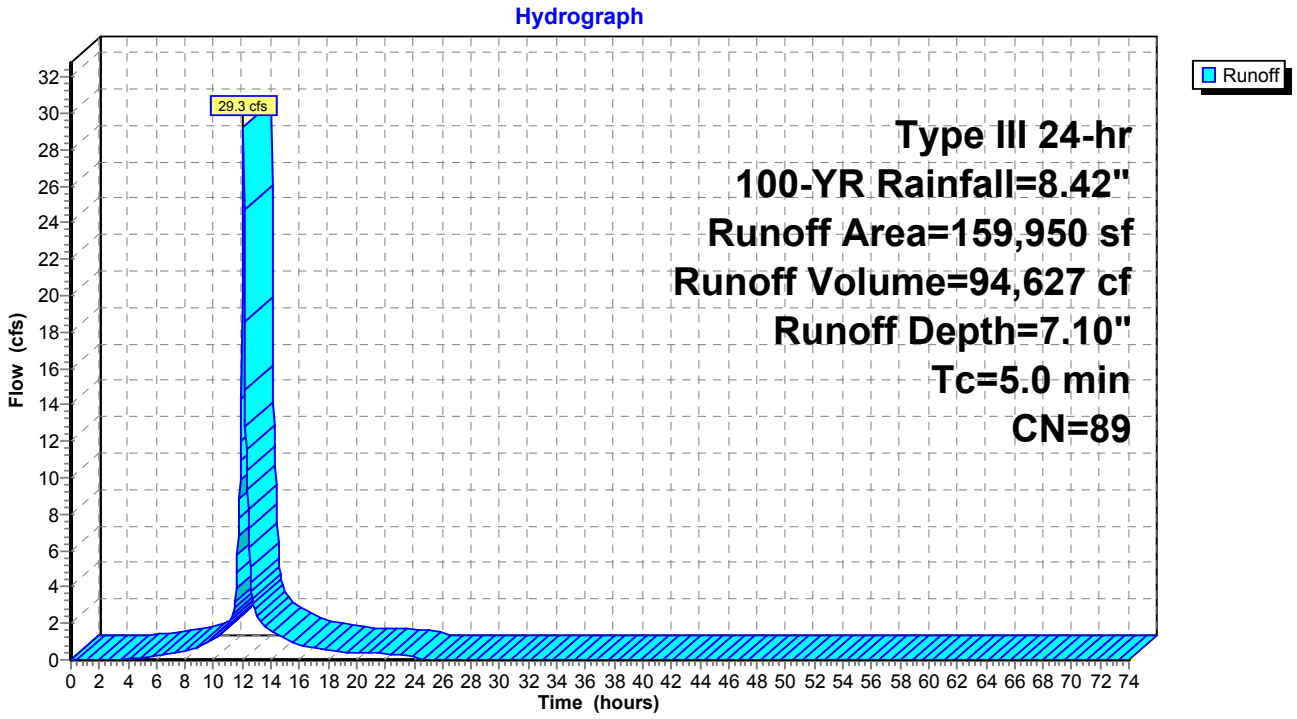
Runoff = 29.3 cfs @ 12.07 hrs, Volume= 94,627 cf, Depth= 7.10"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Type III 24-hr 100-YR Rainfall=8.42"

	Area (sf)	CN	Description
*	126,350	98	Paved parking
	22,700	39	>75% Grass cover, Good, HSG A
	3,850	80	>75% Grass cover, Good, HSG D
	6,900	98	Water Surface, HSG A
*	150	98	Water Surface, HSG D
	159,950	89	Weighted Average
	26,550		16.60% Pervious Area
	133,400		83.40% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 1: Parking Lot



Summary for Subcatchment 2: Parking Lot

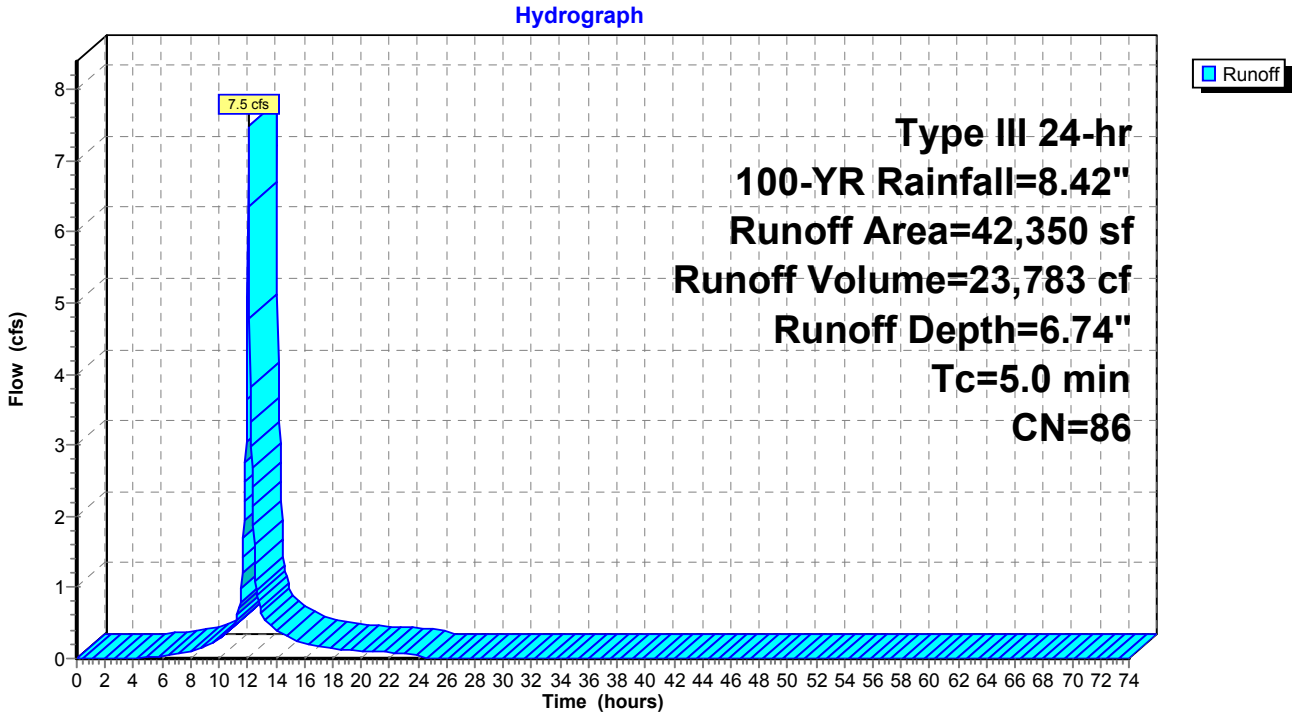
Runoff = 7.5 cfs @ 12.07 hrs, Volume= 23,783 cf, Depth= 6.74"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Type III 24-hr 100-YR Rainfall=8.42"

	Area (sf)	CN	Description
*	33,900	98	Paved parking
	8,450	39	>75% Grass cover, Good, HSG A
	42,350	86	Weighted Average
	8,450		19.95% Pervious Area
	33,900		80.05% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 2: Parking Lot



Summary for Subcatchment 3: Parking

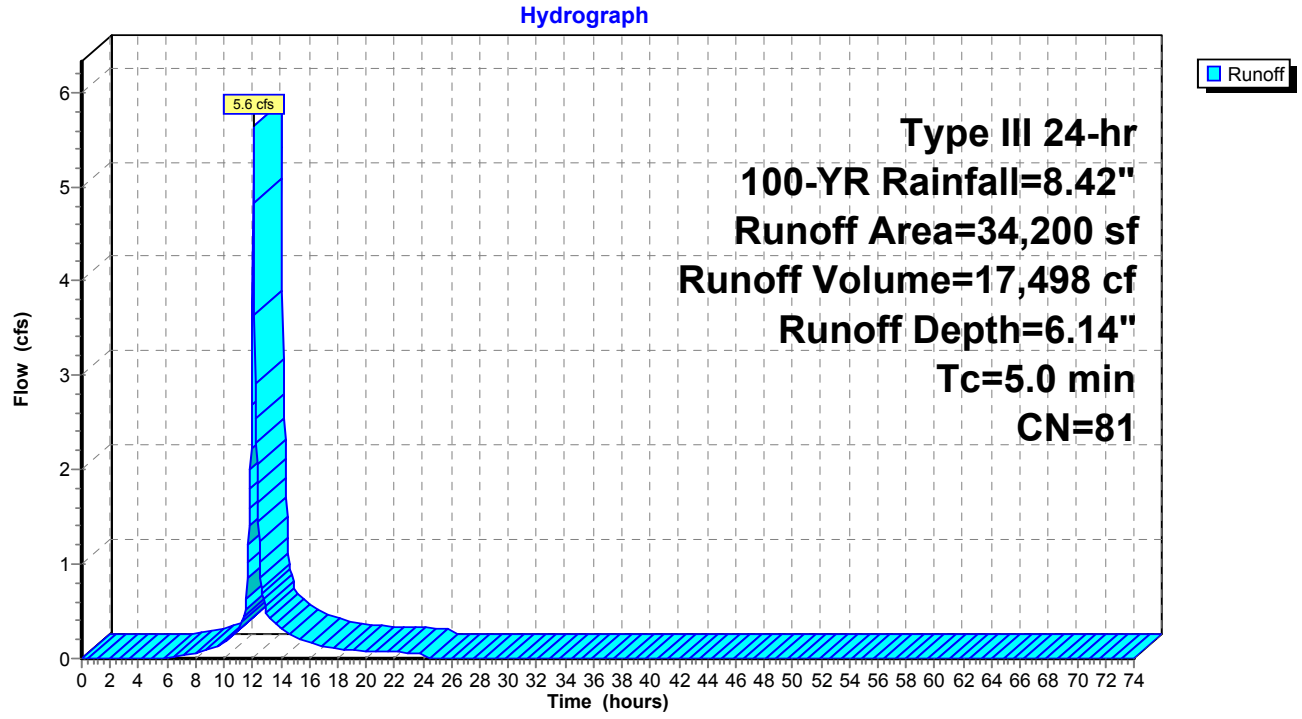
Runoff = 5.6 cfs @ 12.07 hrs, Volume= 17,498 cf, Depth= 6.14"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Type III 24-hr 100-YR Rainfall=8.42"

Area (sf)	CN	Description
24,350	98	Paved parking, HSG A
9,850	39	>75% Grass cover, Good, HSG A
34,200	81	Weighted Average
9,850		28.80% Pervious Area
24,350		71.20% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 3: Parking



Summary for Subcatchment 4: Northwest Grass/Woods

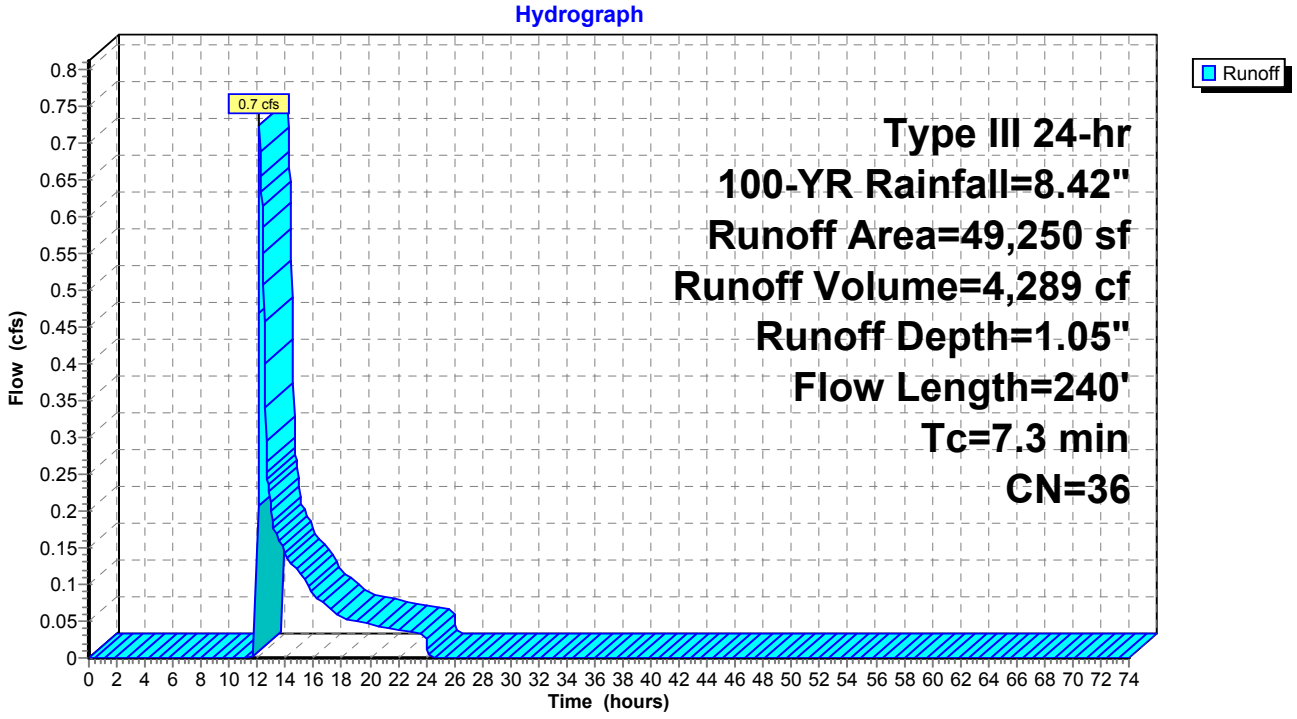
Runoff = 0.7 cfs @ 12.16 hrs, Volume= 4,289 cf, Depth= 1.05"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Type III 24-hr 100-YR Rainfall=8.42"

Area (sf)	CN	Description
30,900	39	>75% Grass cover, Good, HSG A
18,350	30	Woods, Good, HSG A
49,250	36	Weighted Average
49,250		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	20	0.3000	0.35		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.00"
3.3	30	0.0300	0.15		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.00"
2.4	114	0.0130	0.80		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.7	76	0.0130	1.71		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
7.3	240	Total			

Subcatchment 4: Northwest Grass/Woods



Summary for Subcatchment 5: Shoppers World Drive South

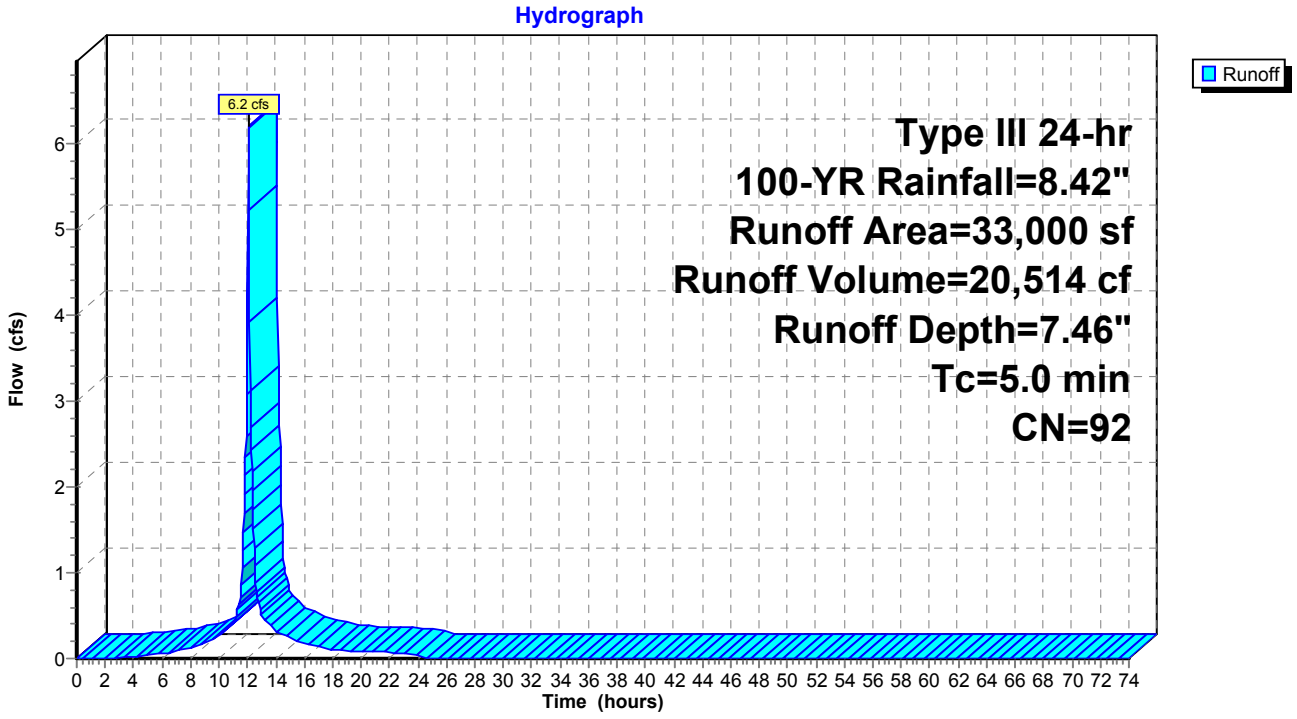
Runoff = 6.2 cfs @ 12.07 hrs, Volume= 20,514 cf, Depth= 7.46"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Type III 24-hr 100-YR Rainfall=8.42"

Area (sf)	CN	Description
29,550	98	Paved parking, HSG A
3,450	39	>75% Grass cover, Good, HSG A
33,000	92	Weighted Average
3,450		10.45% Pervious Area
29,550		89.55% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 5: Shoppers World Drive South



Summary for Pond 1P: Existing Pond - South

Inflow Area = 202,300 sf, 82.70% Impervious, Inflow Depth = 7.02" for 100-YR event
Inflow = 36.8 cfs @ 12.07 hrs, Volume= 118,410 cf
Outflow = 30.1 cfs @ 12.13 hrs, Volume= 118,410 cf, Atten= 18%, Lag= 3.3 min
Primary = 1.5 cfs @ 12.13 hrs, Volume= 895 cf
Secondary = 28.5 cfs @ 12.13 hrs, Volume= 117,515 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Starting Elev= 155.00' Surf.Area= 7,687 sf Storage= 16,436 cf
Peak Elev= 156.40' @ 12.13 hrs Surf.Area= 9,056 sf Storage= 28,177 cf (11,741 cf above start)

Plug-Flow detention time= 112.1 min calculated for 101,919 cf (86% of inflow)
Center-of-Mass det. time= 13.8 min (792.1 - 778.3)

Volume	Invert	Avail.Storage	Storage Description
#1	152.00'	49,544 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

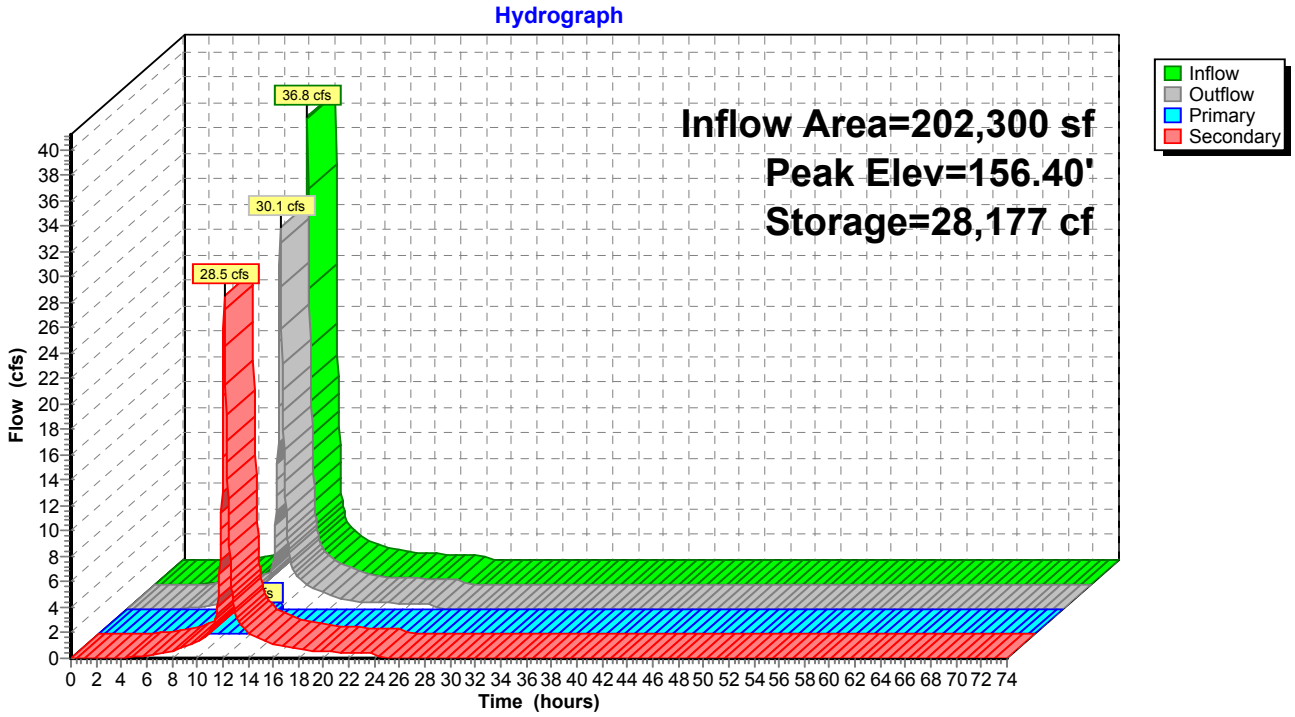
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
152.00	3,444	0	0
153.00	4,709	4,077	4,077
154.00	6,161	5,435	9,512
155.00	7,687	6,924	16,436
156.00	8,650	8,169	24,604
157.00	9,657	9,154	33,758
158.00	10,747	10,202	43,960
158.50	11,591	5,585	49,544

Device	Routing	Invert	Outlet Devices
#1	Primary	155.90'	**30.0" Round Culvert** L= 7.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 155.90' / 153.90' S= 0.2857 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 4.91 sf
#2	Device 1	154.10'	**4.0" Vert. Orifice** C= 0.600
#3	Device 1	155.30'	**45.0 deg Sharp-Crested Vee/Trap Weir** Cv= 2.56 (C= 3.20)
#4	Device 1	158.31'	**48.0" x 48.0" Horiz. Grate** C= 0.600 Limited to weir flow at low heads
#5	Secondary	155.00'	**6.5' long x 20.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=1.5 cfs @ 12.13 hrs HW=156.39' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Passes 1.5 cfs of 1.6 cfs potential flow)
  ├─**2=Orifice** (Orifice Controls 0.3 cfs @ 3.38 fps)
  ├─**3=Sharp-Crested Vee/Trap Weir** (Weir Controls 1.2 cfs @ 2.43 fps)
  └─**4=Grate** (Controls 0.0 cfs)

Secondary OutFlow Max=28.2 cfs @ 12.13 hrs HW=156.39' TW=0.00' (Dynamic Tailwater)
└─**5=Broad-Crested Rectangular Weir** (Weir Controls 28.2 cfs @ 3.12 fps)

Pond 1P: Existing Pond - South



Summary for Pond 2P: Existing Pond - North

Inflow Area = 34,200 sf, 71.20% Impervious, Inflow Depth = 6.14" for 100-YR event
Inflow = 5.6 cfs @ 12.07 hrs, Volume= 17,498 cf
Outflow = 4.1 cfs @ 12.16 hrs, Volume= 15,649 cf, Atten= 28%, Lag= 5.1 min
Primary = 3.3 cfs @ 12.16 hrs, Volume= 15,468 cf
Secondary = 0.8 cfs @ 12.16 hrs, Volume= 181 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Peak Elev= 162.75' @ 12.16 hrs Surf.Area= 2,502 sf Storage= 4,315 cf

Plug-Flow detention time= 90.8 min calculated for 15,640 cf (89% of inflow)
Center-of-Mass det. time= 40.5 min (838.2 - 797.7)

Volume	Invert	Avail.Storage	Storage Description
#1	160.00'	7,631 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

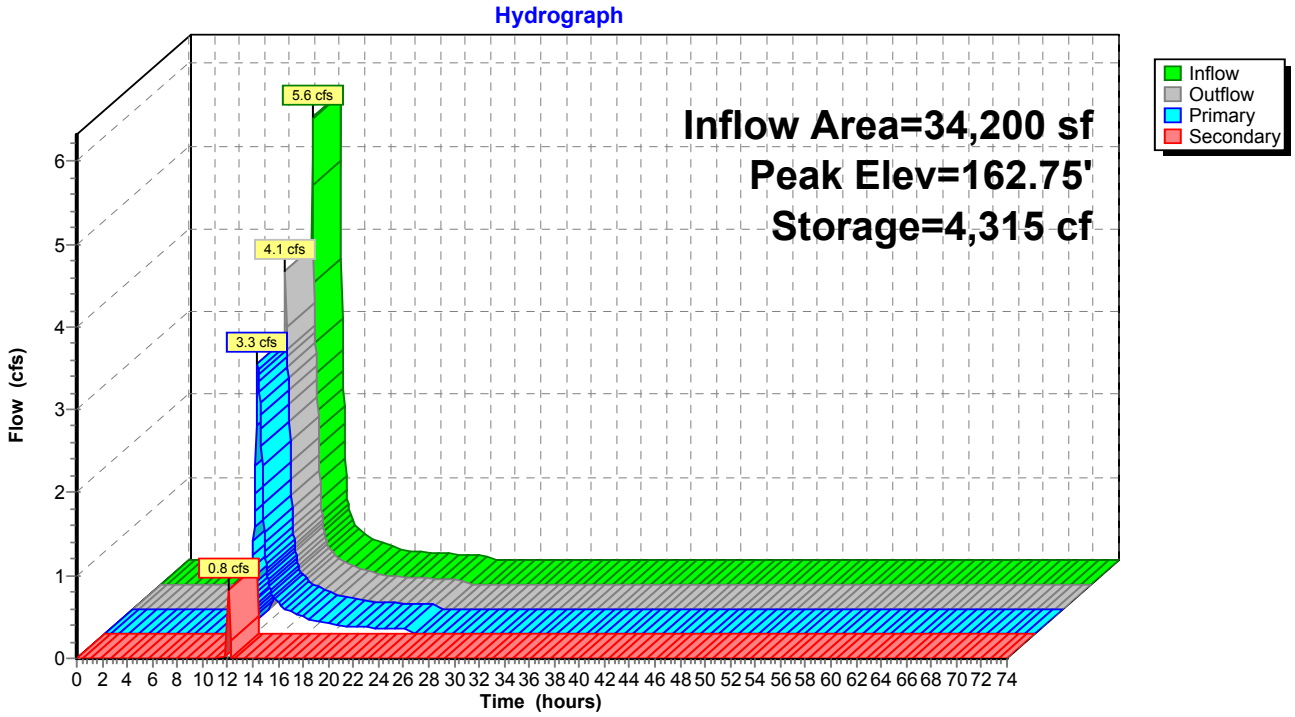
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
160.00	125	0	0
161.00	1,544	835	835
162.00	2,033	1,789	2,623
163.00	2,661	2,347	4,970
164.00	2,661	2,661	7,631

Device	Routing	Invert	Outlet Devices
#1	Primary	161.50'	**12.0" Round Culvert** L= 12.0' RCP, end-section conforming to fill, Ke= 0.500 Inlet / Outlet Invert= 161.50' / 161.20' S= 0.0250 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 0.79 sf
#2	Device 1	161.60'	**4.0' long x 2.00' rise Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#3	Device 1	163.60'	**48.0" W x 48.0" H Vert. Grate** C= 0.600
#4	Secondary	162.70'	**35.0' long x 4.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.38 2.54 2.69 2.68 2.67 2.67 2.65 2.66 2.66 2.68 2.72 2.73 2.76 2.79 2.88 3.07 3.32

Primary OutFlow Max=3.3 cfs @ 12.16 hrs HW=162.75' TW=0.00' (Dynamic Tailwater)
└**1=Culvert** (Inlet Controls 3.3 cfs @ 4.16 fps)
└**2=Sharp-Crested Rectangular Weir** (Passes 3.3 cfs of 15.1 cfs potential flow)
└**3=Grate** (Controls 0.0 cfs)

Secondary OutFlow Max=0.8 cfs @ 12.16 hrs HW=162.75' TW=0.00' (Dynamic Tailwater)
└**4=Broad-Crested Rectangular Weir** (Weir Controls 0.8 cfs @ 0.51 fps)

Pond 2P: Existing Pond - North

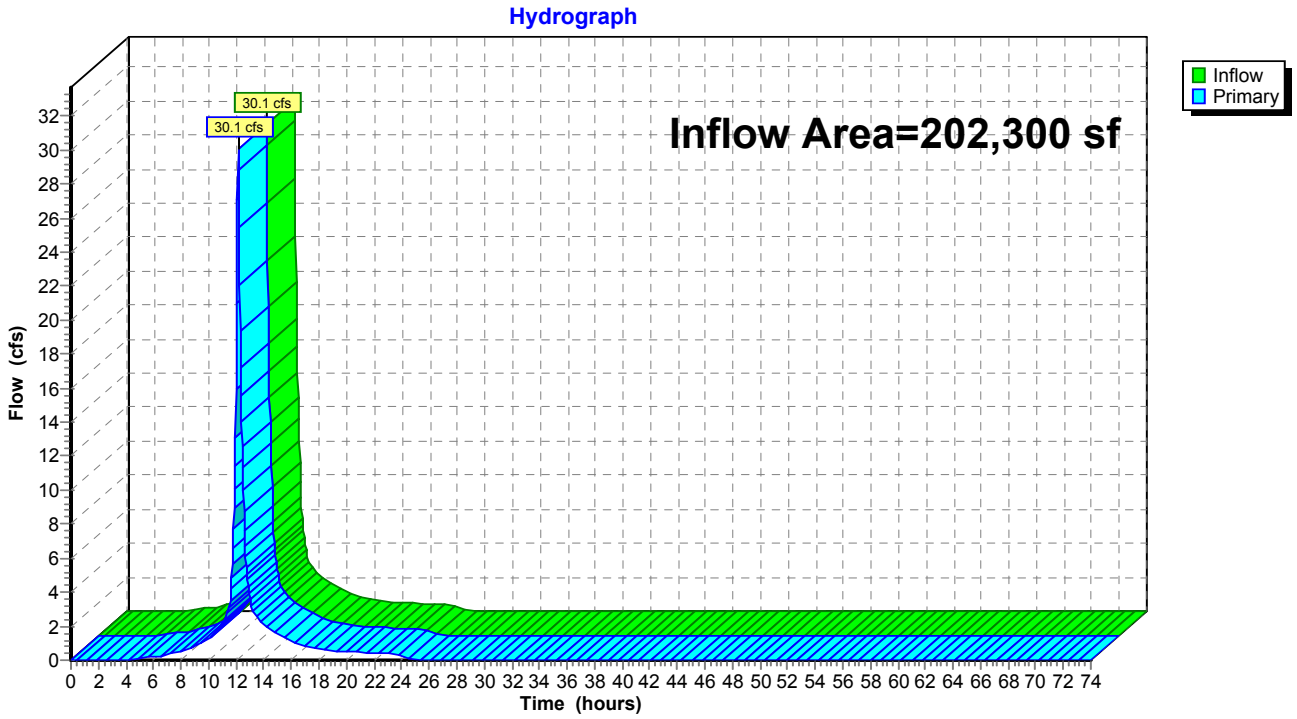


Summary for Link DP 1: South - Wetland

Inflow Area = 202,300 sf, 82.70% Impervious, Inflow Depth = 7.02" for 100-YR event
Inflow = 30.1 cfs @ 12.13 hrs, Volume= 118,410 cf
Primary = 30.1 cfs @ 12.13 hrs, Volume= 118,410 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs

Link DP 1: South - Wetland

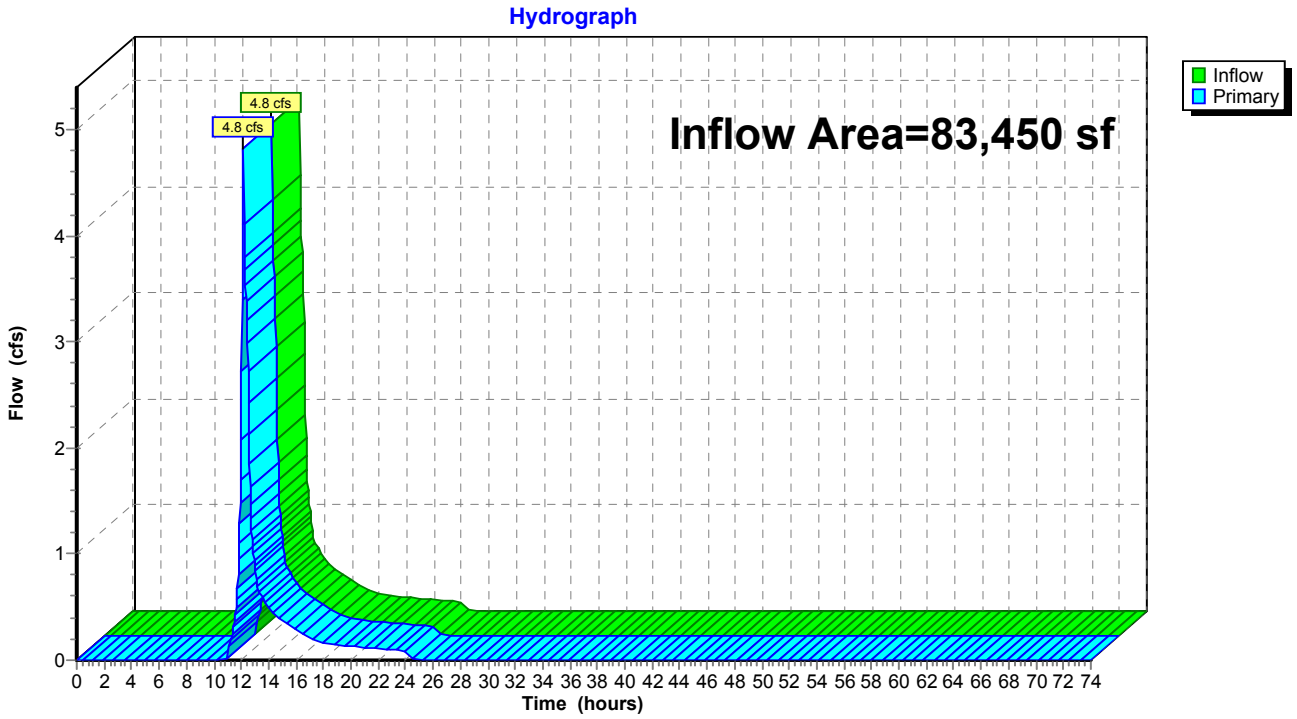


Summary for Link DP 2: North - Culvert

Inflow Area = 83,450 sf, 29.18% Impervious, Inflow Depth = 2.87" for 100-YR event
Inflow = 4.8 cfs @ 12.16 hrs, Volume= 19,938 cf
Primary = 4.8 cfs @ 12.16 hrs, Volume= 19,938 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs

Link DP 2: North - Culvert

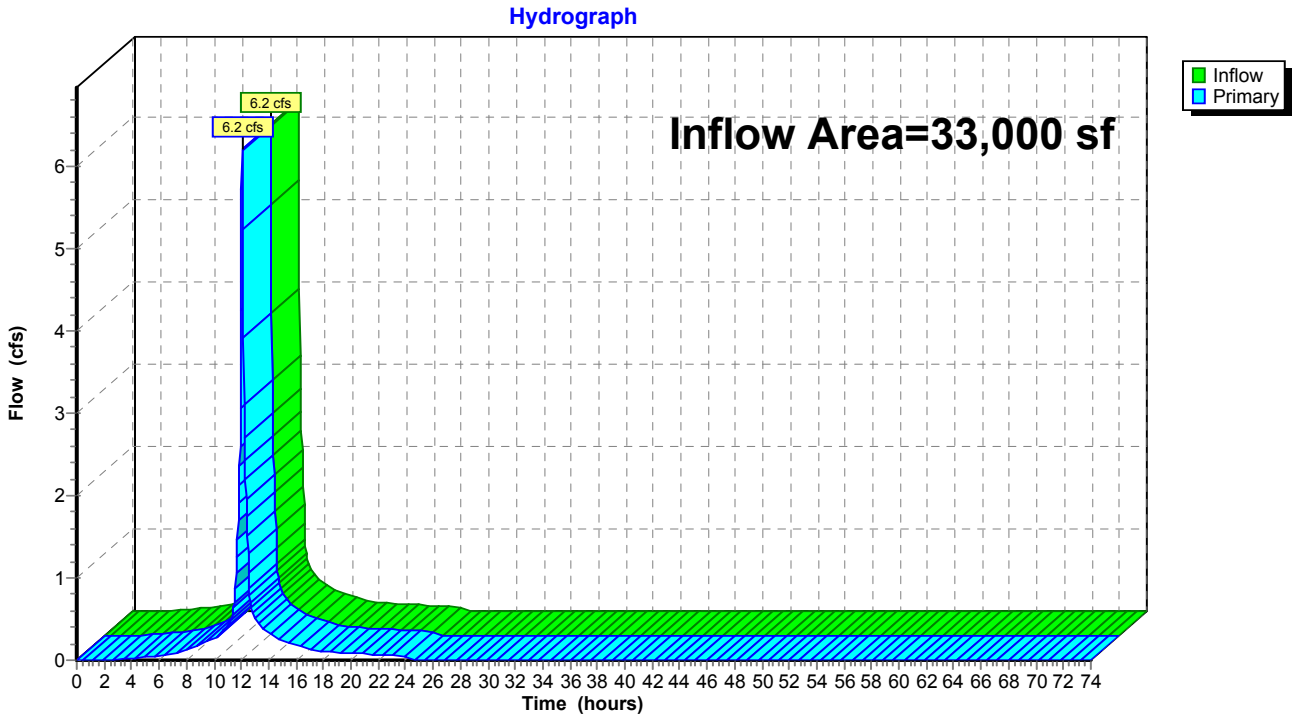


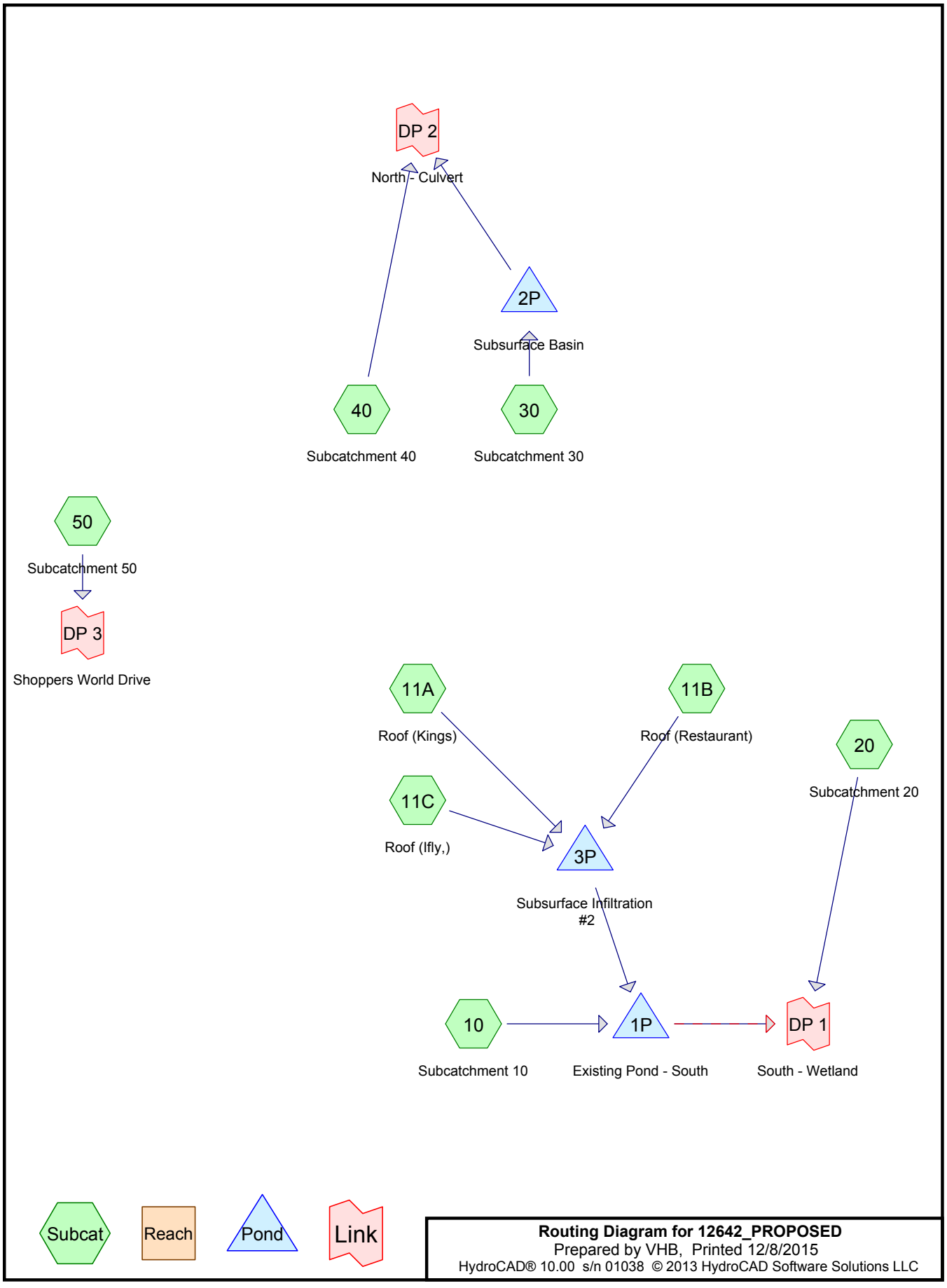
Summary for Link DP3: Shoppers World Drive

Inflow Area = 33,000 sf, 89.55% Impervious, Inflow Depth = 7.46" for 100-YR event
Inflow = 6.2 cfs @ 12.07 hrs, Volume= 20,514 cf
Primary = 6.2 cfs @ 12.07 hrs, Volume= 20,514 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs

Link DP3: Shoppers World Drive





Routing Diagram for 12642_PROPOSED
Prepared by VHB, Printed 12/8/2015

Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
73,759	39	>75% Grass cover, Good, HSG A (10, 20, 30, 40, 50)
1,800	80	>75% Grass cover, Good, HSG D (10)
184,291	98	Paved parking, HSG A (10, 30, 50)
33,518	98	Roofs, HSG A (11A, 11B, 11C)
6,895	98	Water Surface, 0% imp, HSG A (10)
140	98	Water Surface, 0% imp, HSG D (10)
18,347	30	Woods, Good, HSG A (40)
318,750	**80**	**TOTAL AREA**

2- Year-Storm-Event-Proposed

Summary for Subcatchment 10: Subcatchment 10

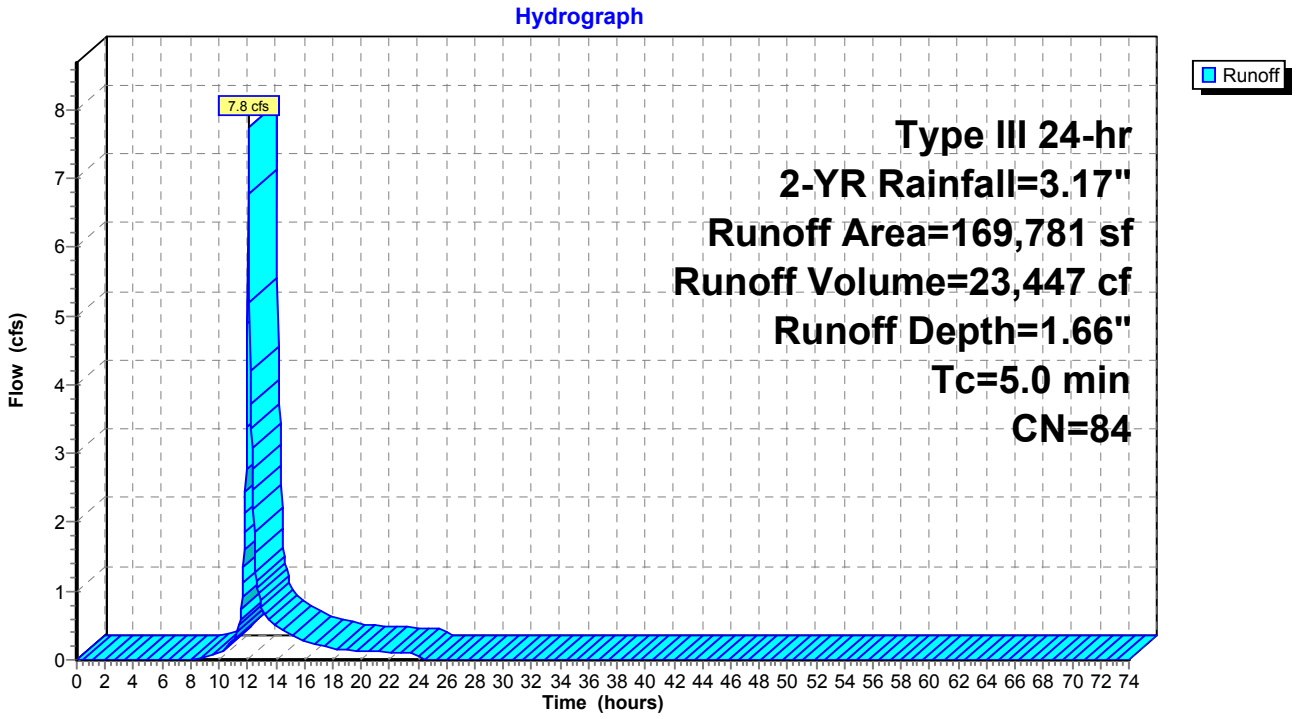
Runoff = 7.8 cfs @ 12.08 hrs, Volume= 23,447 cf, Depth= 1.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Type III 24-hr 2-YR Rainfall=3.17"

Area (sf)	CN	Description
121,346	98	Paved parking, HSG A
6,895	98	Water Surface, 0% imp, HSG A
140	98	Water Surface, 0% imp, HSG D
39,600	39	>75% Grass cover, Good, HSG A
1,800	80	>75% Grass cover, Good, HSG D
169,781	84	Weighted Average
48,435		28.53% Pervious Area
121,346		71.47% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 10: Subcatchment 10



Summary for Subcatchment 11A: Roof (Kings)

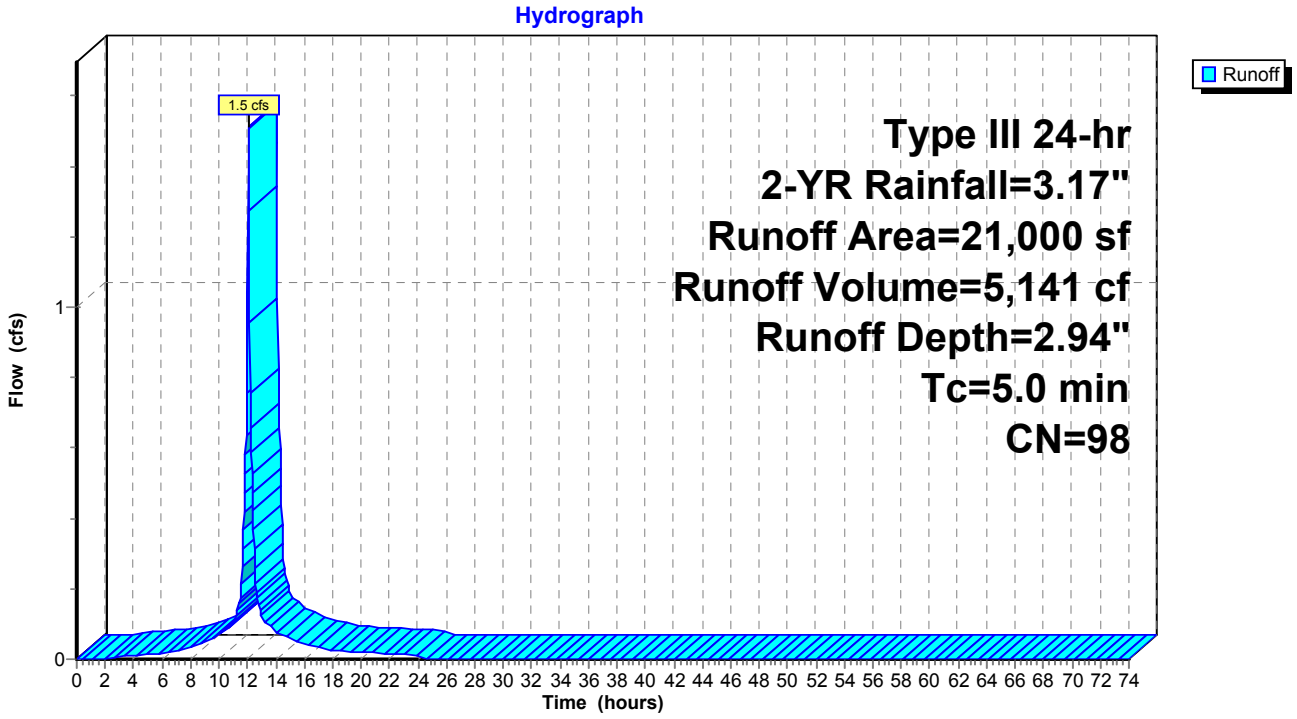
Runoff = 1.5 cfs @ 12.07 hrs, Volume= 5,141 cf, Depth= 2.94"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Type III 24-hr 2-YR Rainfall=3.17"

Area (sf)	CN	Description
21,000	98	Roofs, HSG A
21,000		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 11A: Roof (Kings)



Summary for Subcatchment 11B: Roof (Restaurant)

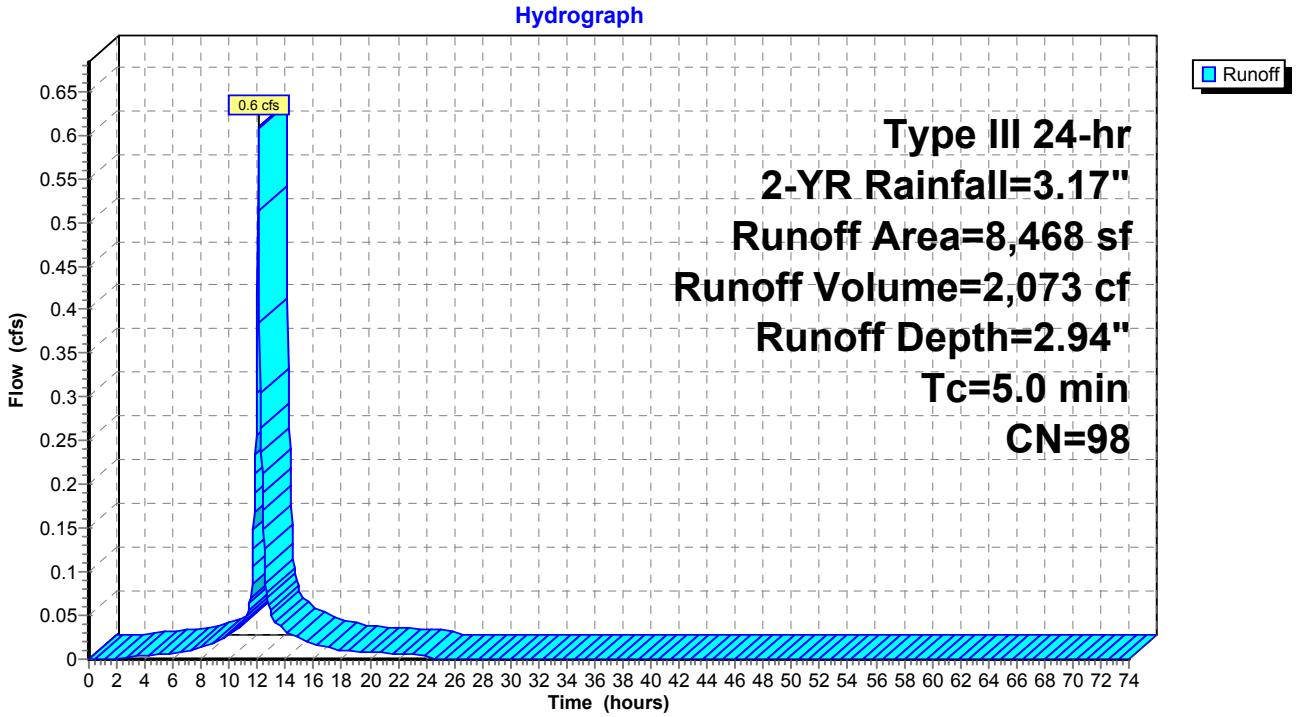
Runoff = 0.6 cfs @ 12.07 hrs, Volume= 2,073 cf, Depth= 2.94"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Type III 24-hr 2-YR Rainfall=3.17"

Area (sf)	CN	Description
8,468	98	Roofs, HSG A
8,468		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 11B: Roof (Restaurant)



Summary for Subcatchment 11C: Roof (Ifly,)

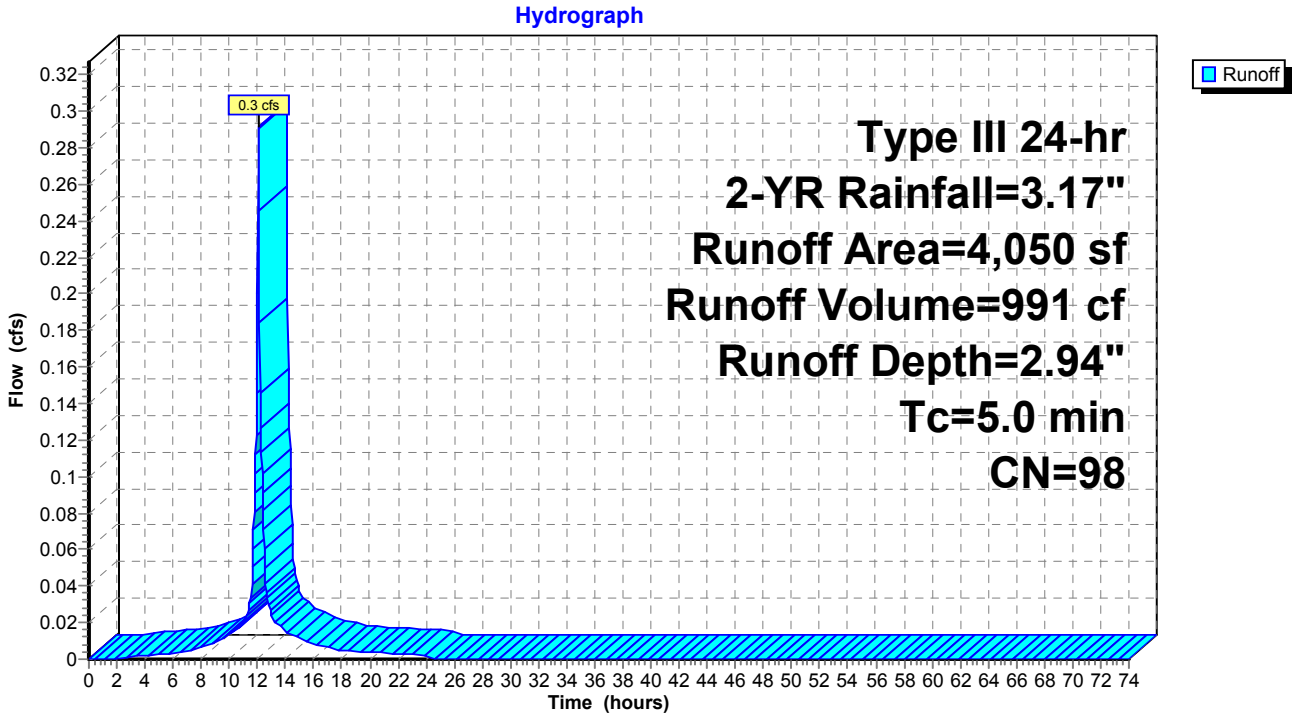
Runoff = 0.3 cfs @ 12.07 hrs, Volume= 991 cf, Depth= 2.94"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Type III 24-hr 2-YR Rainfall=3.17"

Area (sf)	CN	Description
4,050	98	Roofs, HSG A
4,050		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 11C: Roof (Ifly,)



Summary for Subcatchment 20: Subcatchment 20

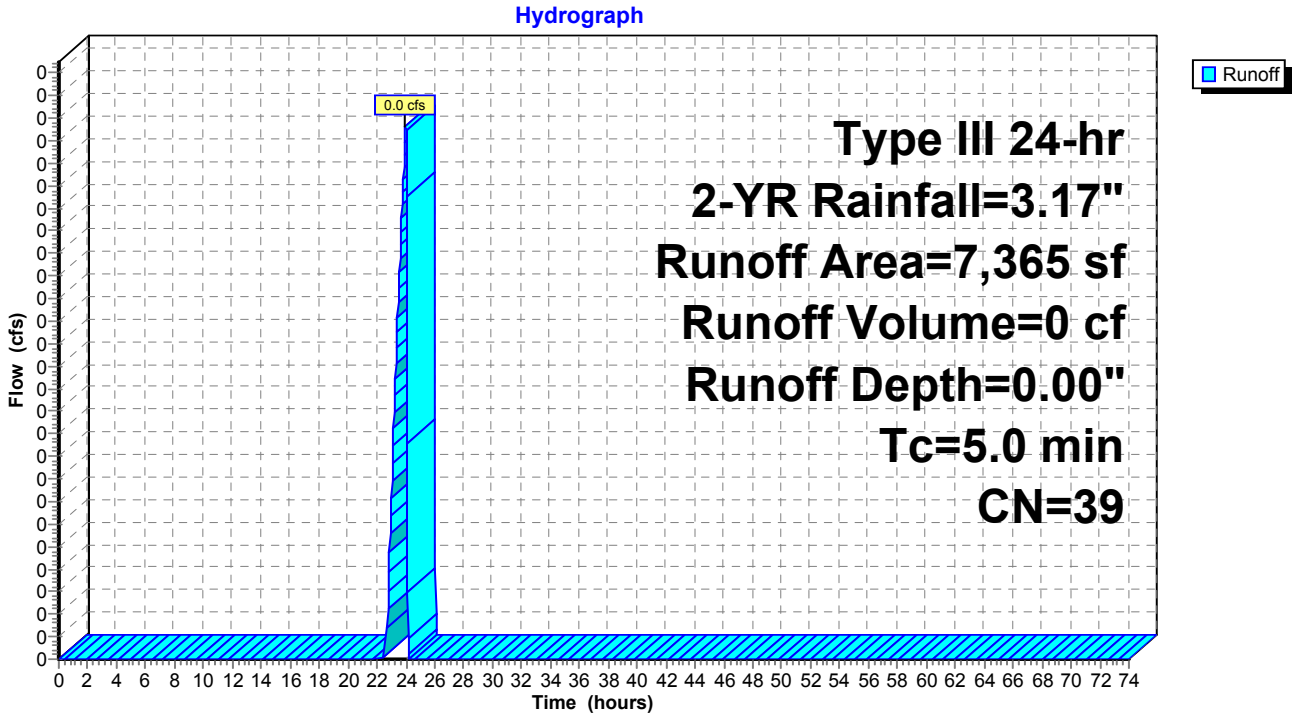
Runoff = 0.0 cfs @ 23.99 hrs, Volume= 0 cf, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Type III 24-hr 2-YR Rainfall=3.17"

Area (sf)	CN	Description
7,365	39	>75% Grass cover, Good, HSG A
7,365		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 20: Subcatchment 20



Summary for Subcatchment 30: Subcatchment 30

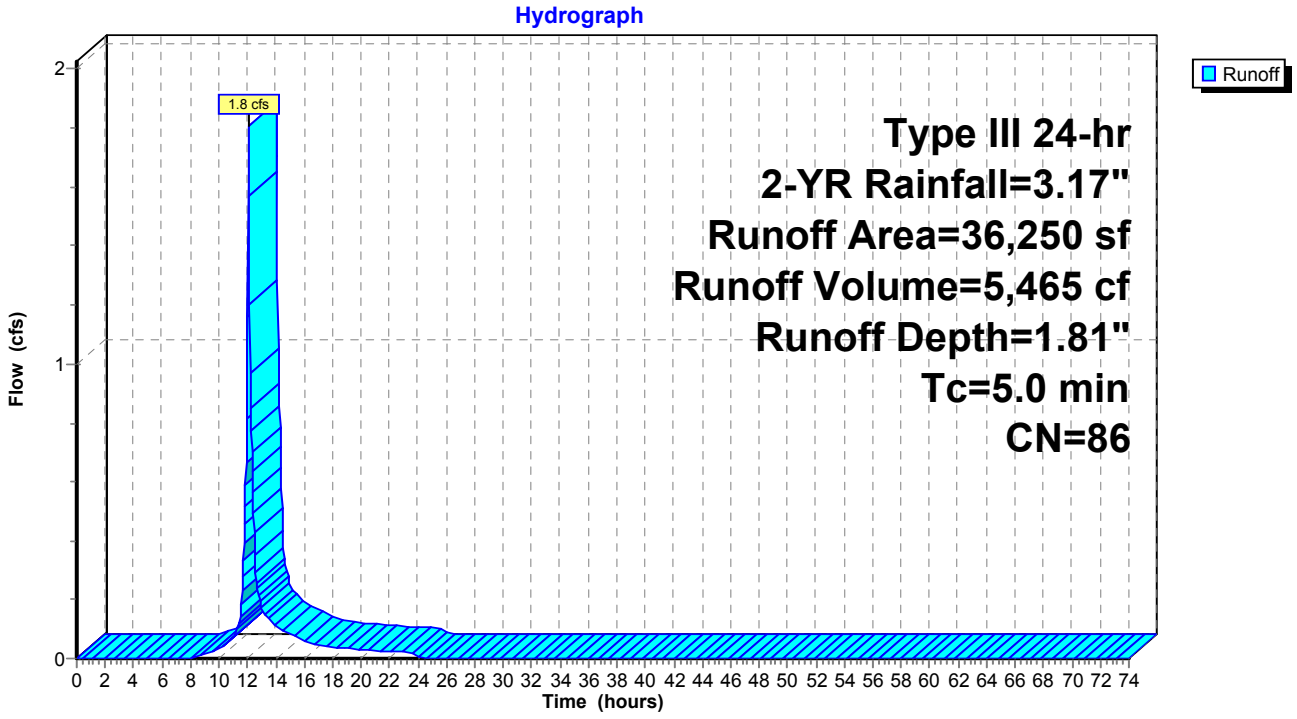
Runoff = 1.8 cfs @ 12.08 hrs, Volume= 5,465 cf, Depth= 1.81"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Type III 24-hr 2-YR Rainfall=3.17"

Area (sf)	CN	Description
28,950	98	Paved parking, HSG A
7,300	39	>75% Grass cover, Good, HSG A
36,250	86	Weighted Average
7,300		20.14% Pervious Area
28,950		79.86% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 30: Subcatchment 30



Summary for Subcatchment 40: Subcatchment 40

[45] Hint: Runoff=Zero

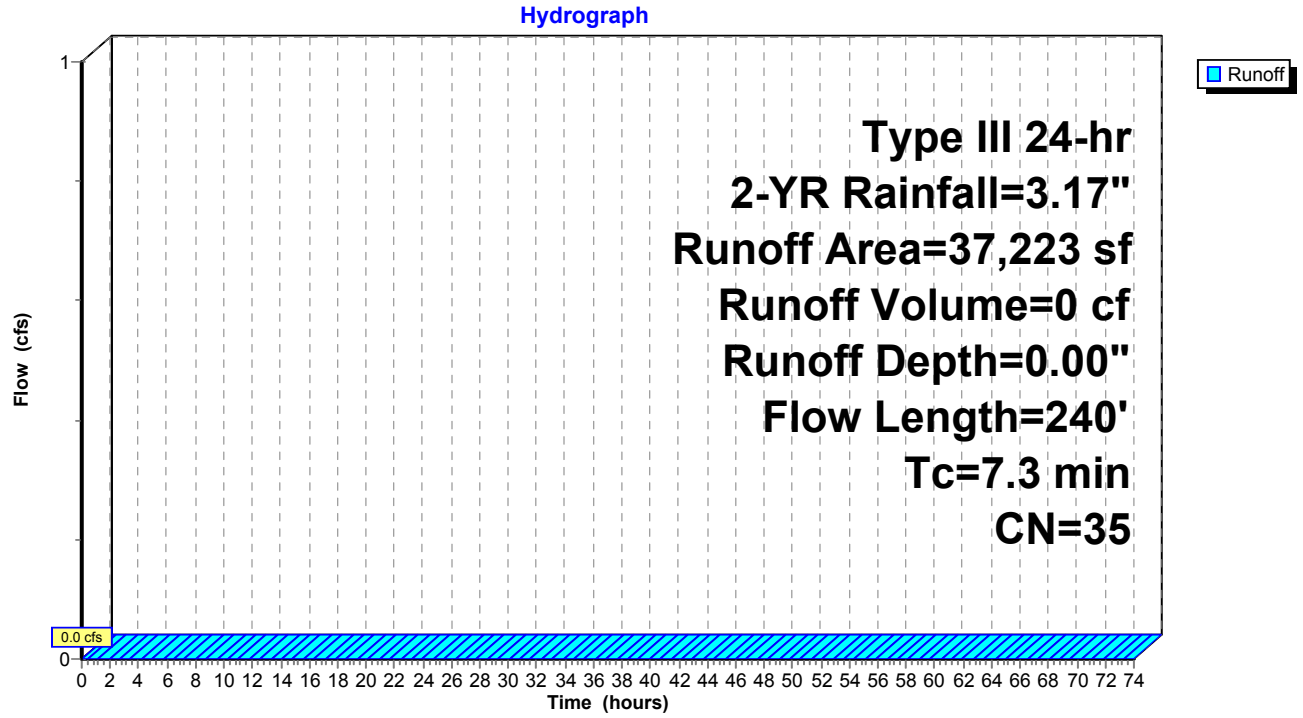
Runoff = 0.0 cfs @ 0.00 hrs, Volume= 0 cf, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Type III 24-hr 2-YR Rainfall=3.17"

Area (sf)	CN	Description
18,876	39	>75% Grass cover, Good, HSG A
18,347	30	Woods, Good, HSG A
37,223	35	Weighted Average
37,223		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	20	0.3000	0.35		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.00"
3.3	30	0.0300	0.15		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.00"
2.4	114	0.0130	0.80		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.7	76	0.0130	1.71		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
7.3	240	Total			

Subcatchment 40: Subcatchment 40



Summary for Subcatchment 50: Subcatchment 50

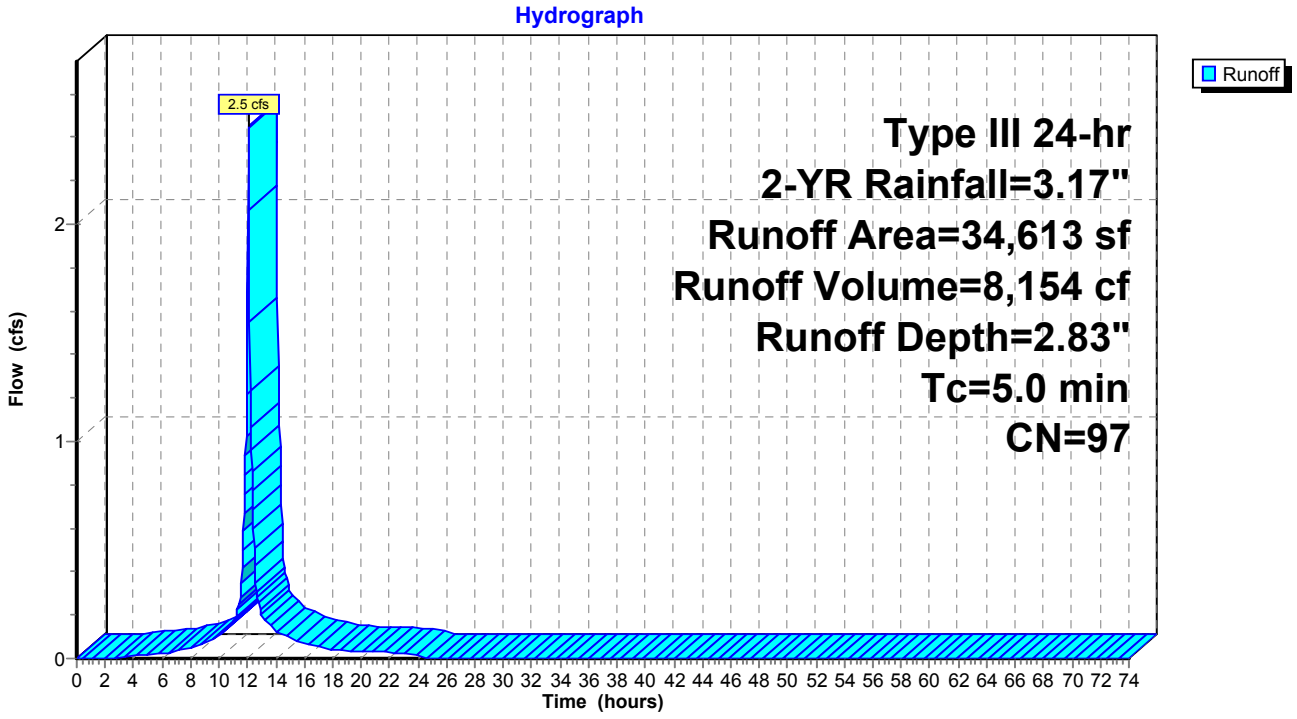
Runoff = 2.5 cfs @ 12.07 hrs, Volume= 8,154 cf, Depth= 2.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Type III 24-hr 2-YR Rainfall=3.17"

Area (sf)	CN	Description
33,995	98	Paved parking, HSG A
618	39	>75% Grass cover, Good, HSG A
34,613	97	Weighted Average
618		1.79% Pervious Area
33,995		98.21% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 50: Subcatchment 50



Summary for Pond 1P: Existing Pond - South

Inflow Area = 203,299 sf, 76.18% Impervious, Inflow Depth = 1.67" for 2-YR event
Inflow = 10.2 cfs @ 12.08 hrs, Volume= 28,240 cf
Outflow = 7.1 cfs @ 12.16 hrs, Volume= 28,240 cf, Atten= 30%, Lag= 4.8 min
Primary = 0.0 cfs @ 0.00 hrs, Volume= 0 cf
Secondary = 7.1 cfs @ 12.16 hrs, Volume= 28,240 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Starting Elev= 155.00' Surf.Area= 7,687 sf Storage= 16,436 cf
Peak Elev= 155.55' @ 12.16 hrs Surf.Area= 8,215 sf Storage= 20,793 cf (4,358 cf above start)

Plug-Flow detention time= 275.9 min calculated for 11,798 cf (42% of inflow)
Center-of-Mass det. time= 20.1 min (836.2 - 816.1)

Volume	Invert	Avail.Storage	Storage Description
#1	152.00'	49,544 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

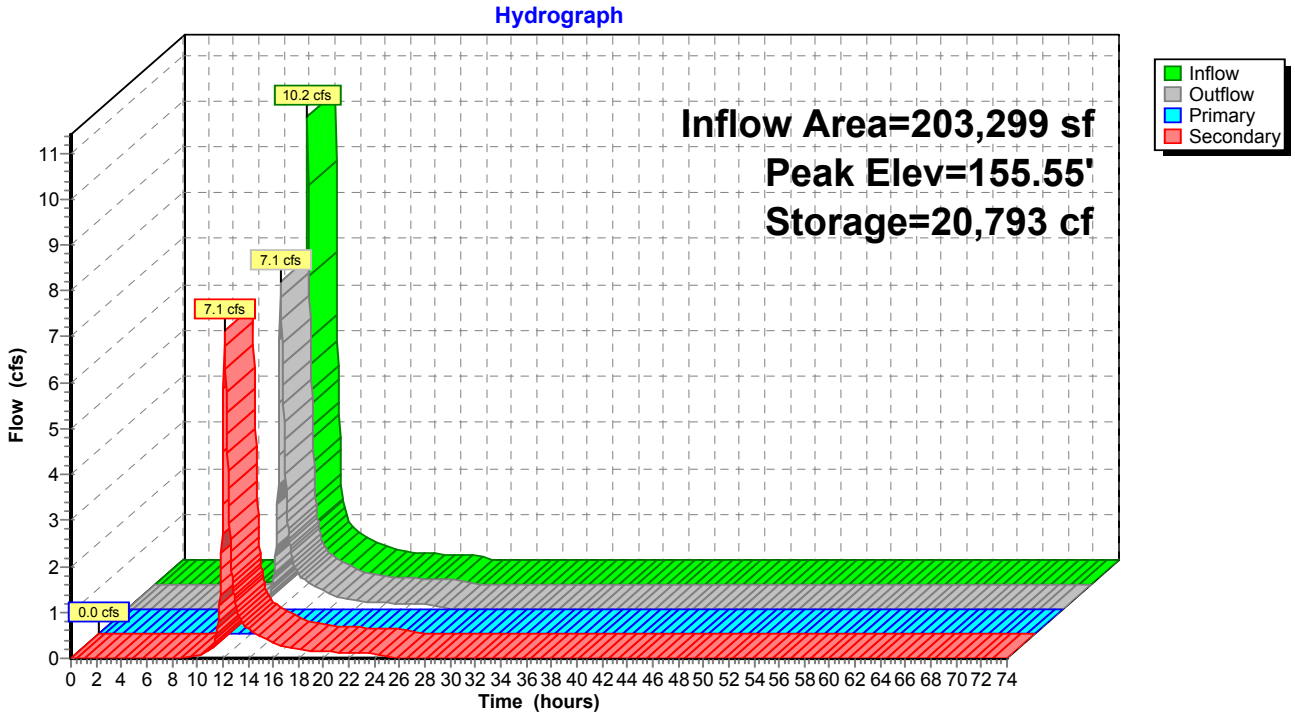
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
152.00	3,444	0	0
153.00	4,709	4,077	4,077
154.00	6,161	5,435	9,512
155.00	7,687	6,924	16,436
156.00	8,650	8,169	24,604
157.00	9,657	9,154	33,758
158.00	10,747	10,202	43,960
158.50	11,591	5,585	49,544

Device	Routing	Invert	Outlet Devices
#1	Primary	155.90'	**30.0" Round Culvert** L= 7.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 155.90' / 153.90' S= 0.2857 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 4.91 sf
#2	Device 1	154.10'	**4.0" Vert. Orifice** C= 0.600
#3	Device 1	155.30'	**45.0 deg Sharp-Crested Vee/Trap Weir** Cv= 2.56 (C= 3.20)
#4	Device 1	158.31'	**48.0" x 48.0" Horiz. Grate** C= 0.600 Limited to weir flow at low heads
#5	Secondary	155.00'	**6.5' long x 20.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=0.0 cfs @ 0.00 hrs HW=155.00' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Controls 0.0 cfs)
  └─**2=Orifice** (Controls 0.0 cfs)
  └─**3=Sharp-Crested Vee/Trap Weir** (Controls 0.0 cfs)
  └─**4=Grate** (Controls 0.0 cfs)

Secondary OutFlow Max=7.1 cfs @ 12.16 hrs HW=155.55' TW=0.00' (Dynamic Tailwater)
└─**5=Broad-Crested Rectangular Weir** (Weir Controls 7.1 cfs @ 2.00 fps)

Pond 1P: Existing Pond - South



Summary for Pond 2P: Subsurface Basin

[87] Warning: Oscillations may require smaller dt or Finer Routing (severity=91)

Inflow Area = 36,250 sf, 79.86% Impervious, Inflow Depth = 1.81" for 2-YR event
Inflow = 1.8 cfs @ 12.08 hrs, Volume= 5,465 cf
Outflow = 0.3 cfs @ 12.59 hrs, Volume= 5,472 cf, Atten= 85%, Lag= 31.0 min
Discarded = 0.2 cfs @ 12.59 hrs, Volume= 5,345 cf
Primary = 0.0 cfs @ 12.59 hrs, Volume= 127 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Peak Elev= 160.82' @ 12.59 hrs Surf.Area= 3,898 sf Storage= 1,760 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 55.7 min (877.8 - 822.0)

Volume	Invert	Avail.Storage	Storage Description
#1A	160.00'	2,726 cf	**38.17'W x 102.12'L x 2.33'H Field A** 9,094 cf Overall - 2,280 cf Embedded = 6,814 cf x 40.0% Voids
#2A	160.50'	2,280 cf	**ADS_StormTech SC-310** x 154 Inside #1 Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap Row Length Adjustment= +0.44' x 2.07 sf x 11 rows
		5,006 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	160.00'	**2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 0.00'
#2	Primary	162.30'	**3.7' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#3	Primary	160.70'	**8.0" Vert. Orifice/Grate** C= 0.600
#4	Primary	161.50'	**8.0" Vert. Orifice/Grate** C= 0.600

Discarded OutFlow Max=0.2 cfs @ 12.59 hrs HW=160.82' (Free Discharge)
└**1=Exfiltration** (Controls 0.2 cfs)

Primary OutFlow Max=0.0 cfs @ 12.59 hrs HW=160.82' TW=0.00' (Dynamic Tailwater)
├**2=Broad-Crested Rectangular Weir** (Controls 0.0 cfs)
├**3=Orifice/Grate** (Orifice Controls 0.0 cfs @ 1.16 fps)
└**4=Orifice/Grate** (Controls 0.0 cfs)

Pond 2P: Subsurface Basin - Chamber Wizard Field A

Chamber Model = ADS_StormTechSC-310 (ADS StormTech® SC-310)
Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf
Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap
Row Length Adjustment= +0.44' x 2.07 sf x 11 rows

34.0" Wide + 6.0" Spacing = 40.0" C-C Row Spacing

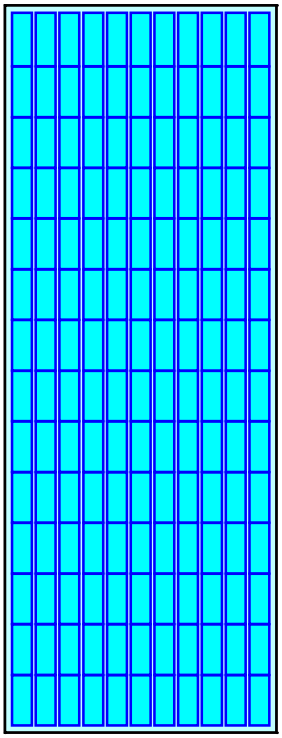
14 Chambers/Row x 7.12' Long +0.44' Row Adjustment = 100.12' Row Length +12.0" End Stone x 2 = 102.12' Base Length
11 Rows x 34.0" Wide + 6.0" Spacing x 10 + 12.0" Side Stone x 2 = 38.17' Base Width
6.0" Base + 16.0" Chamber Height + 6.0" Cover = 2.33' Field Height

154 Chambers x 14.7 cf +0.44' Row Adjustment x 2.07 sf x 11 Rows = 2,280.2 cf Chamber Storage

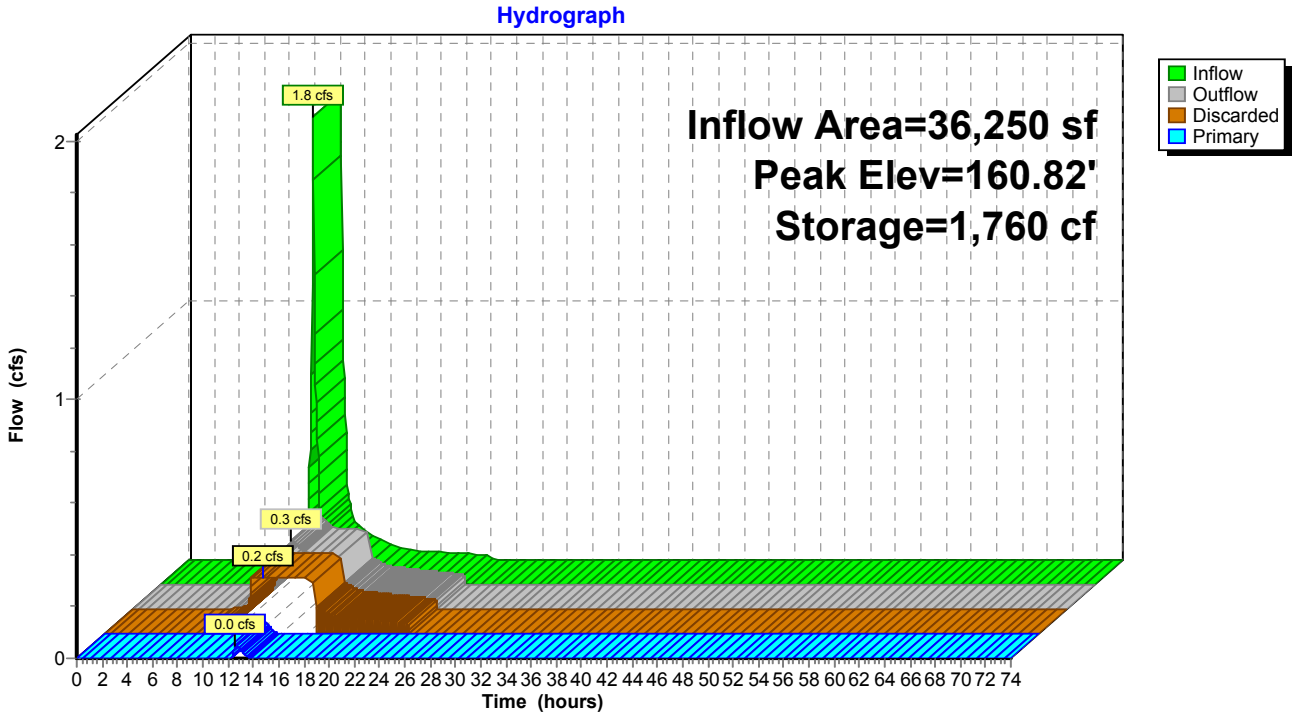
9,094.2 cf Field - 2,280.2 cf Chambers = 6,814.0 cf Stone x 40.0% Voids = 2,725.6 cf Stone Storage

Chamber Storage + Stone Storage = 5,005.8 cf = 0.1 af
Overall Storage Efficiency = 55.0%

154 Chambers
336.8 cy Field
252.4 cy Stone



Pond 2P: Subsurface Basin



Summary for Pond 3P: Subsurface Infiltration #2

[93] Warning: Storage range exceeded by 0.32'
[90] Warning: Qout>Qin may require smaller dt or Finer Routing
[87] Warning: Oscillations may require smaller dt or Finer Routing (severity=31)

Inflow Area =	33,518 sf,100.00% Impervious,	Inflow Depth =	2.94"	for 2-YR event
Inflow =	2.4 cfs @ 12.07 hrs,	Volume=	8,205 cf	
Outflow =	2.5 cfs @ 12.07 hrs,	Volume=	8,206 cf,	Atten= 0%, Lag= 0.1 min
Discarded =	0.0 cfs @ 12.07 hrs,	Volume=	3,413 cf	
Primary =	2.4 cfs @ 12.07 hrs,	Volume=	4,793 cf	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Peak Elev= 159.15' @ 12.07 hrs Surf.Area= 691 sf Storage= 869 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 96.1 min (851.8 - 755.7)

Volume	Invert	Avail.Storage	Storage Description
#1A	156.50'	496 cf	**18.17'W x 38.04'L x 2.33'H Field A** 1,612 cf Overall - 373 cf Embedded = 1,239 cf x 40.0% Voids
#2A	157.00'	373 cf	**ADS_StormTech SC-310** x 25 Inside #1 Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap Row Length Adjustment= +0.44' x 2.07 sf x 5 rows
		869 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	156.50'	**2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 0.00'
#2	Primary	158.80'	**4.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Discarded OutFlow Max=0.0 cfs @ 12.07 hrs HW=159.15' (Free Discharge)
↑**1=Exfiltration** (Controls 0.0 cfs)

Primary OutFlow Max=2.4 cfs @ 12.07 hrs HW=159.15' TW=155.47' (Dynamic Tailwater)
↑**2=Broad-Crested Rectangular Weir** (Weir Controls 2.4 cfs @ 1.71 fps)

Pond 3P: Subsurface Infiltration #2 - Chamber Wizard Field A

Chamber Model = ADS_StormTechSC-310 (ADS StormTech® SC-310)
Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf
Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap
Row Length Adjustment= +0.44' x 2.07 sf x 5 rows

34.0" Wide + 6.0" Spacing = 40.0" C-C Row Spacing

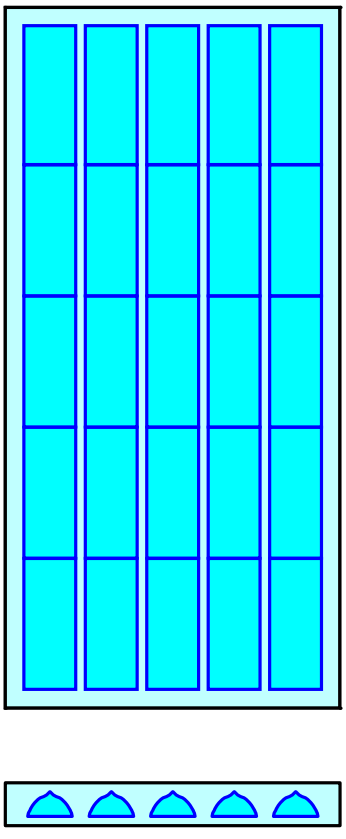
5 Chambers/Row x 7.12' Long +0.44' Row Adjustment = 36.04' Row Length +12.0" End Stone x 2 = 38.04' Base Length
5 Rows x 34.0" Wide + 6.0" Spacing x 4 + 12.0" Side Stone x 2 = 18.17' Base Width
6.0" Base + 16.0" Chamber Height + 6.0" Cover = 2.33' Field Height

25 Chambers x 14.7 cf +0.44' Row Adjustment x 2.07 sf x 5 Rows = 373.1 cf Chamber Storage

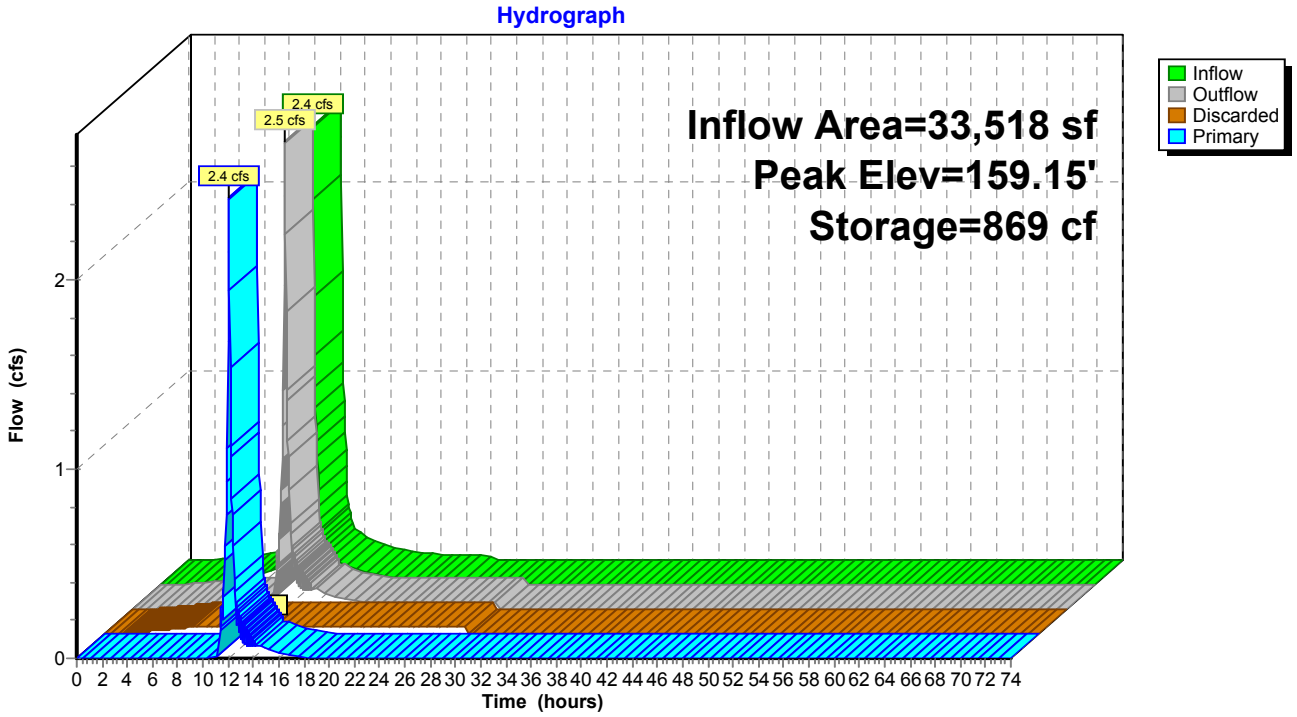
1,612.4 cf Field - 373.1 cf Chambers = 1,239.3 cf Stone x 40.0% Voids = 495.7 cf Stone Storage

Chamber Storage + Stone Storage = 868.8 cf = 0.0 af
Overall Storage Efficiency = 53.9%

25 Chambers
59.7 cy Field
45.9 cy Stone



Pond 3P: Subsurface Infiltration #2

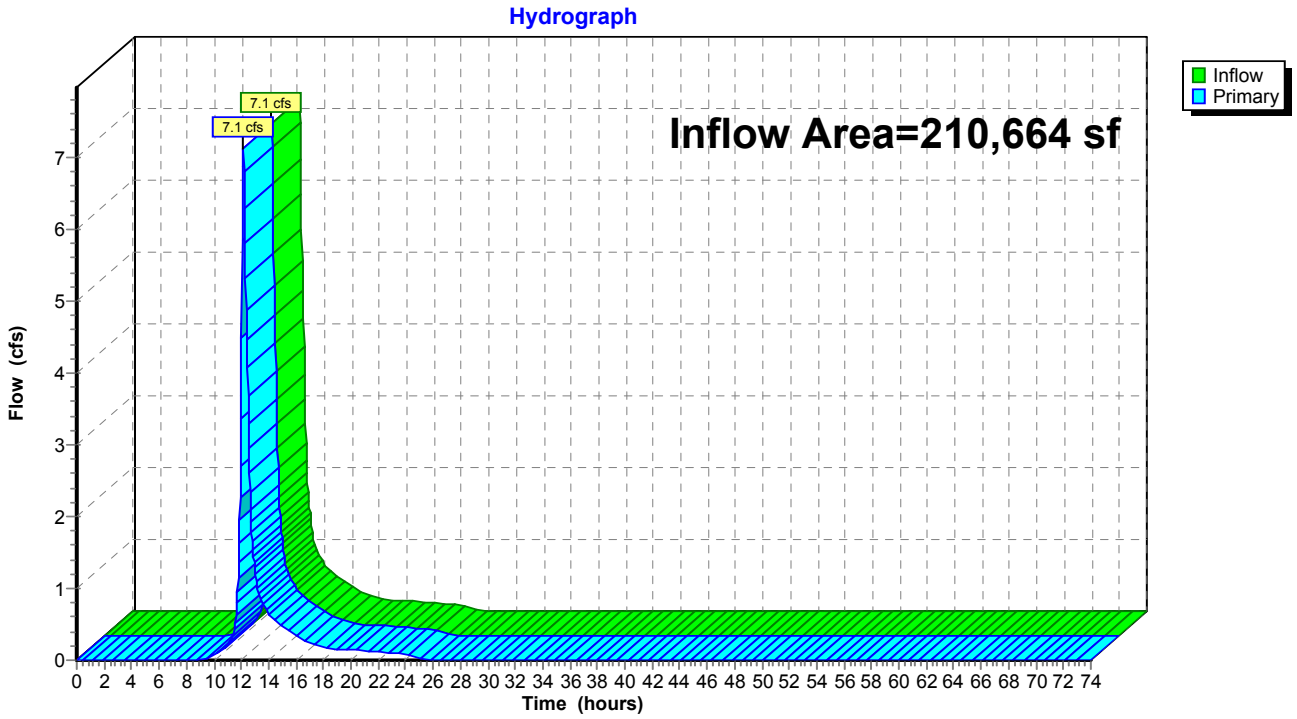


Summary for Link DP 1: South - Wetland

Inflow Area = 210,664 sf, 73.51% Impervious, Inflow Depth = 1.61" for 2-YR event
Inflow = 7.1 cfs @ 12.16 hrs, Volume= 28,240 cf
Primary = 7.1 cfs @ 12.16 hrs, Volume= 28,240 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs

Link DP 1: South - Wetland

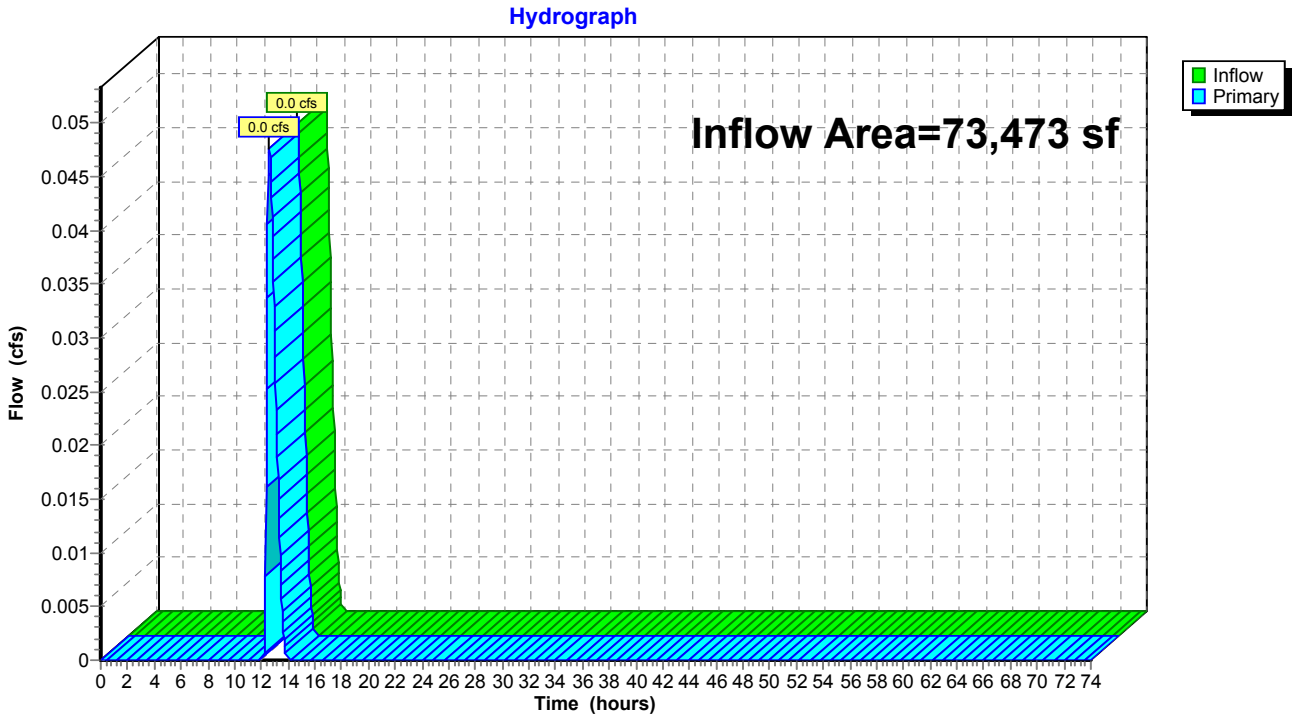


Summary for Link DP 2: North - Culvert

Inflow Area = 73,473 sf, 39.40% Impervious, Inflow Depth = 0.02" for 2-YR event
Inflow = 0.0 cfs @ 12.59 hrs, Volume= 127 cf
Primary = 0.0 cfs @ 12.59 hrs, Volume= 127 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs

Link DP 2: North - Culvert

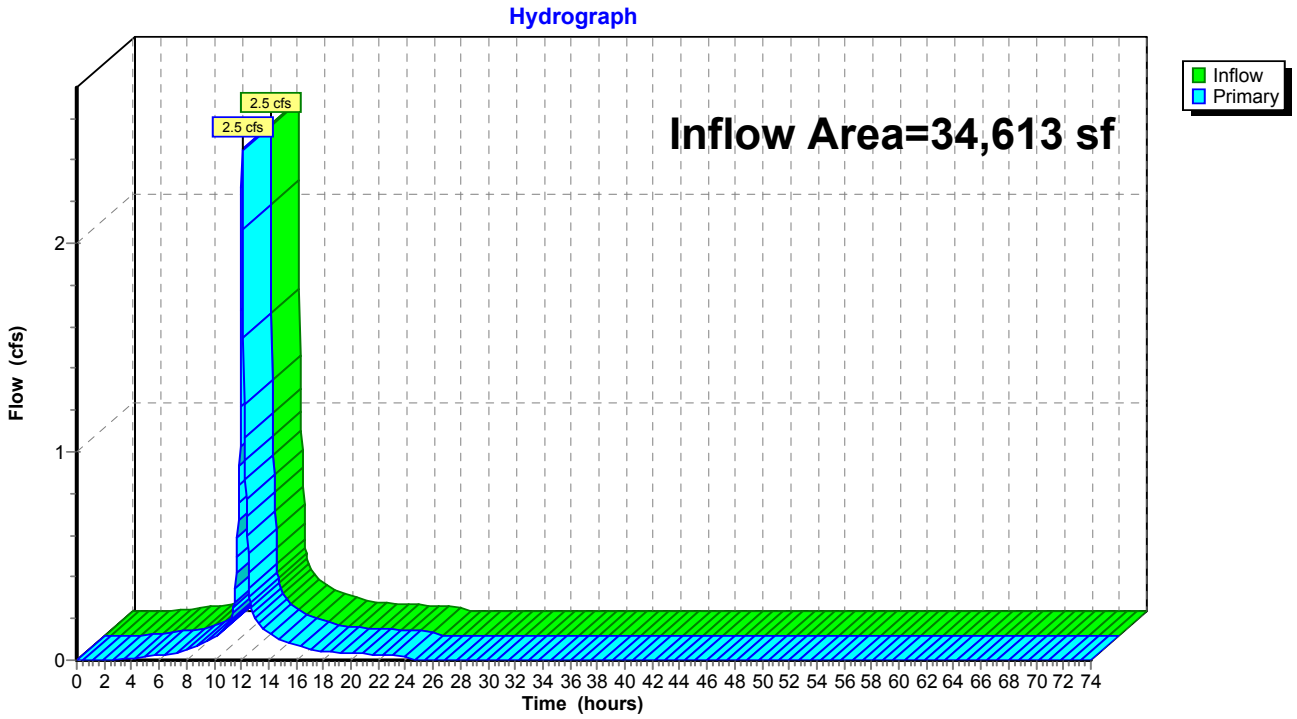


Summary for Link DP 3: Shoppers World Drive

Inflow Area = 34,613 sf, 98.21% Impervious, Inflow Depth = 2.83" for 2-YR event
Inflow = 2.5 cfs @ 12.07 hrs, Volume= 8,154 cf
Primary = 2.5 cfs @ 12.07 hrs, Volume= 8,154 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs

Link DP 3: Shoppers World Drive



10- Year-Storm-Event-Proposed

Summary for Subcatchment 10: Subcatchment 10

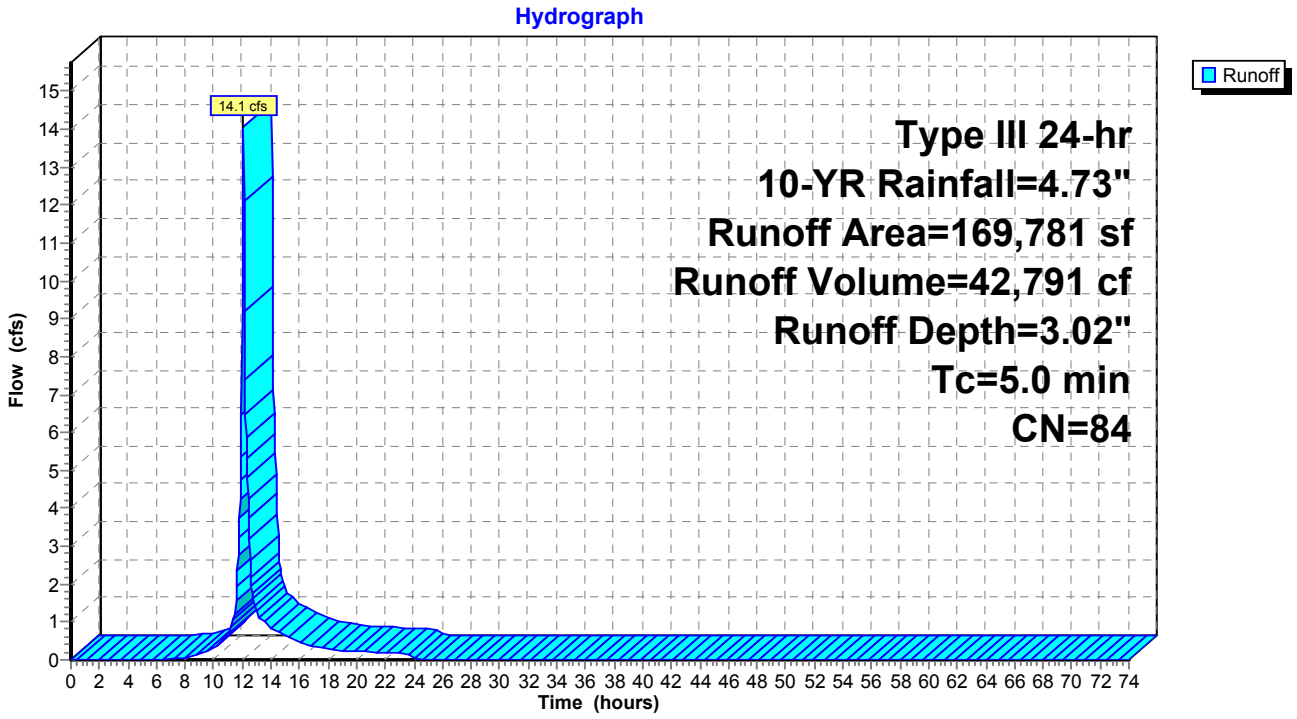
Runoff = 14.1 cfs @ 12.08 hrs, Volume= 42,791 cf, Depth= 3.02"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Type III 24-hr 10-YR Rainfall=4.73"

Area (sf)	CN	Description
121,346	98	Paved parking, HSG A
6,895	98	Water Surface, 0% imp, HSG A
140	98	Water Surface, 0% imp, HSG D
39,600	39	>75% Grass cover, Good, HSG A
1,800	80	>75% Grass cover, Good, HSG D
169,781	84	Weighted Average
48,435		28.53% Pervious Area
121,346		71.47% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 10: Subcatchment 10



Summary for Subcatchment 11A: Roof (Kings)

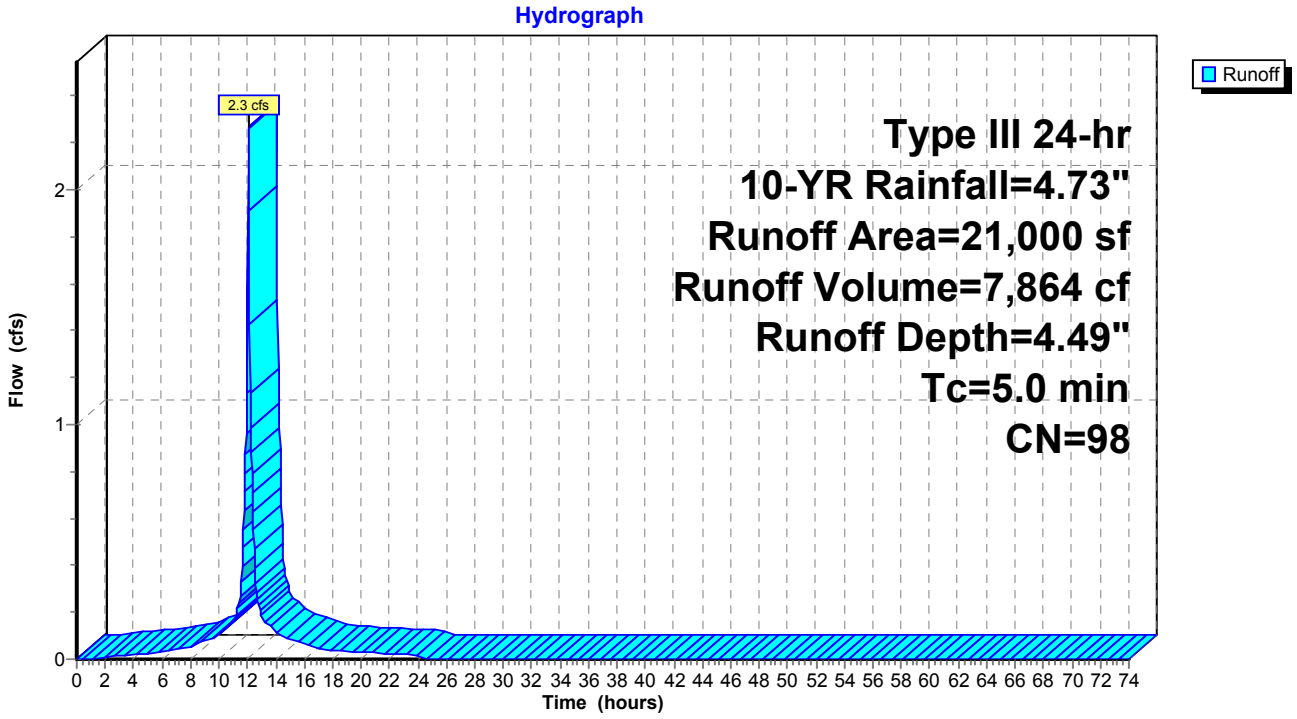
Runoff = 2.3 cfs @ 12.07 hrs, Volume= 7,864 cf, Depth= 4.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Type III 24-hr 10-YR Rainfall=4.73"

Area (sf)	CN	Description
21,000	98	Roofs, HSG A
21,000		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 11A: Roof (Kings)



Summary for Subcatchment 11B: Roof (Restaurant)

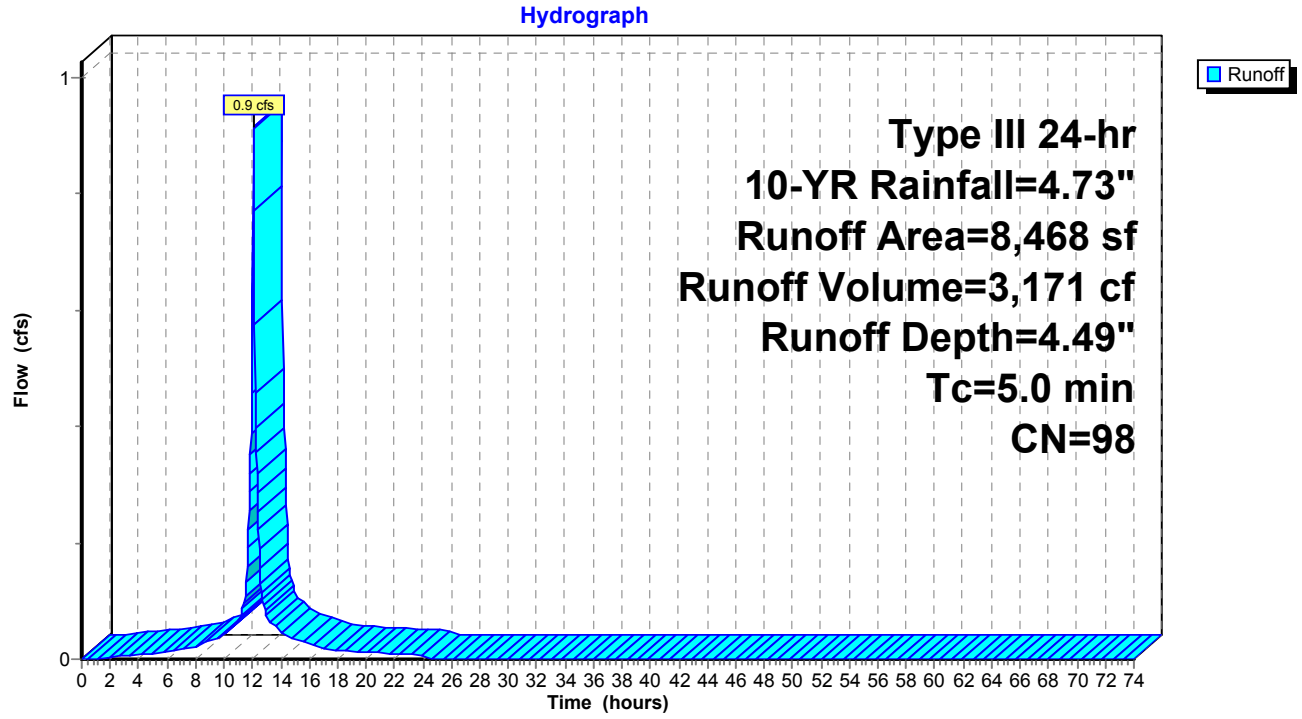
Runoff = 0.9 cfs @ 12.07 hrs, Volume= 3,171 cf, Depth= 4.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Type III 24-hr 10-YR Rainfall=4.73"

Area (sf)	CN	Description
8,468	98	Roofs, HSG A
8,468		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 11B: Roof (Restaurant)



Summary for Subcatchment 11C: Roof (lfly,)

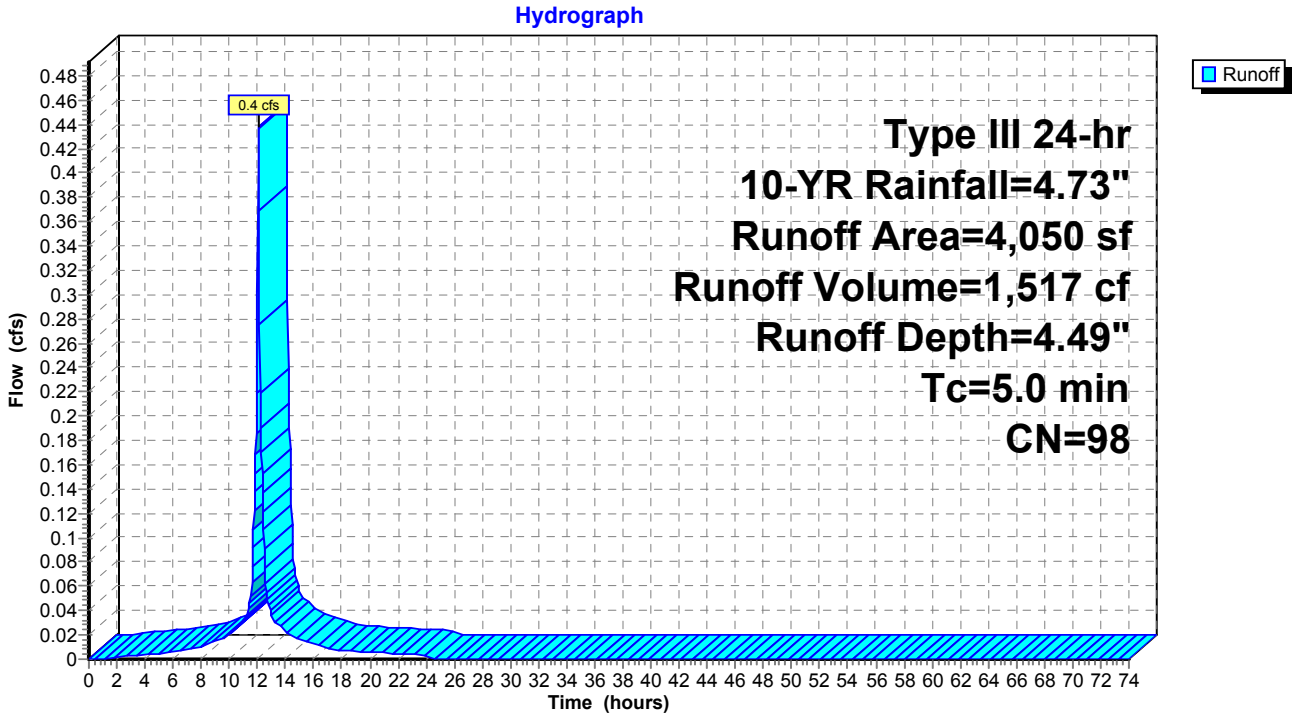
Runoff = 0.4 cfs @ 12.07 hrs, Volume= 1,517 cf, Depth= 4.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Type III 24-hr 10-YR Rainfall=4.73"

Area (sf)	CN	Description
4,050	98	Roofs, HSG A
4,050		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 11C: Roof (lfly,)



Summary for Subcatchment 20: Subcatchment 20

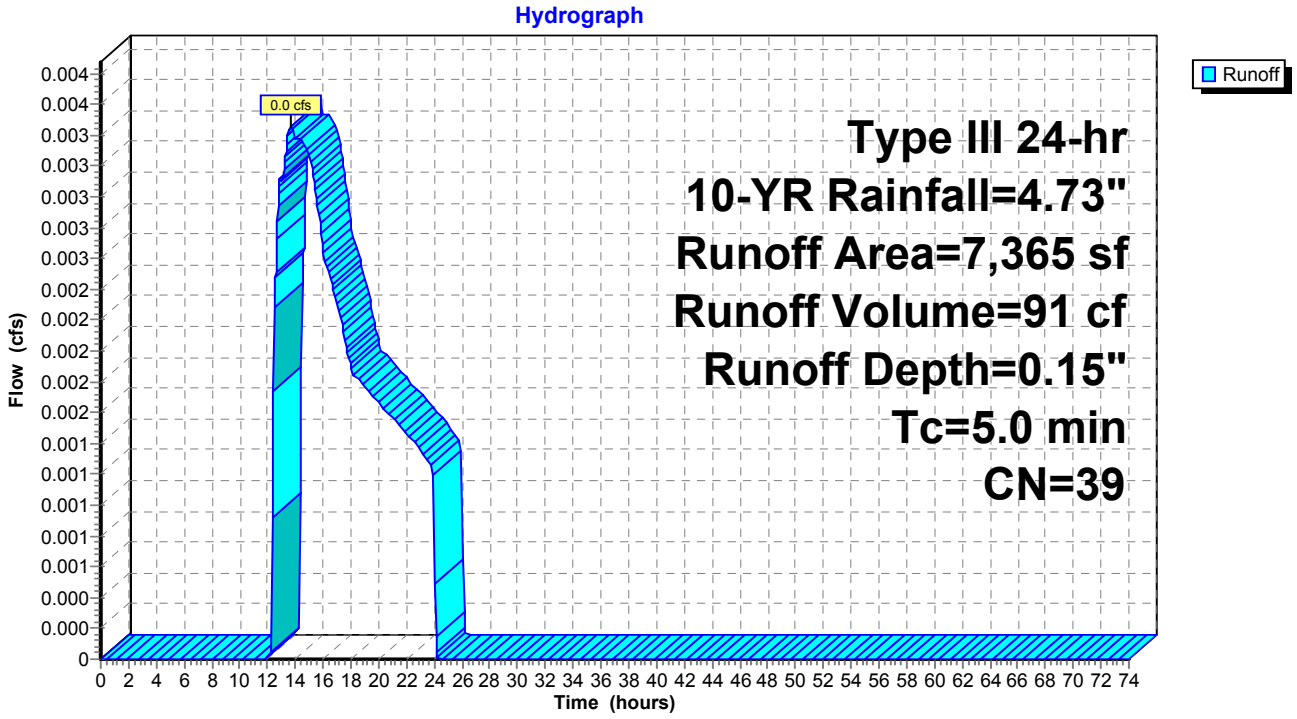
Runoff = 0.0 cfs @ 13.72 hrs, Volume= 91 cf, Depth= 0.15"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Type III 24-hr 10-YR Rainfall=4.73"

Area (sf)	CN	Description
7,365	39	>75% Grass cover, Good, HSG A
7,365		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 20: Subcatchment 20



Summary for Subcatchment 30: Subcatchment 30

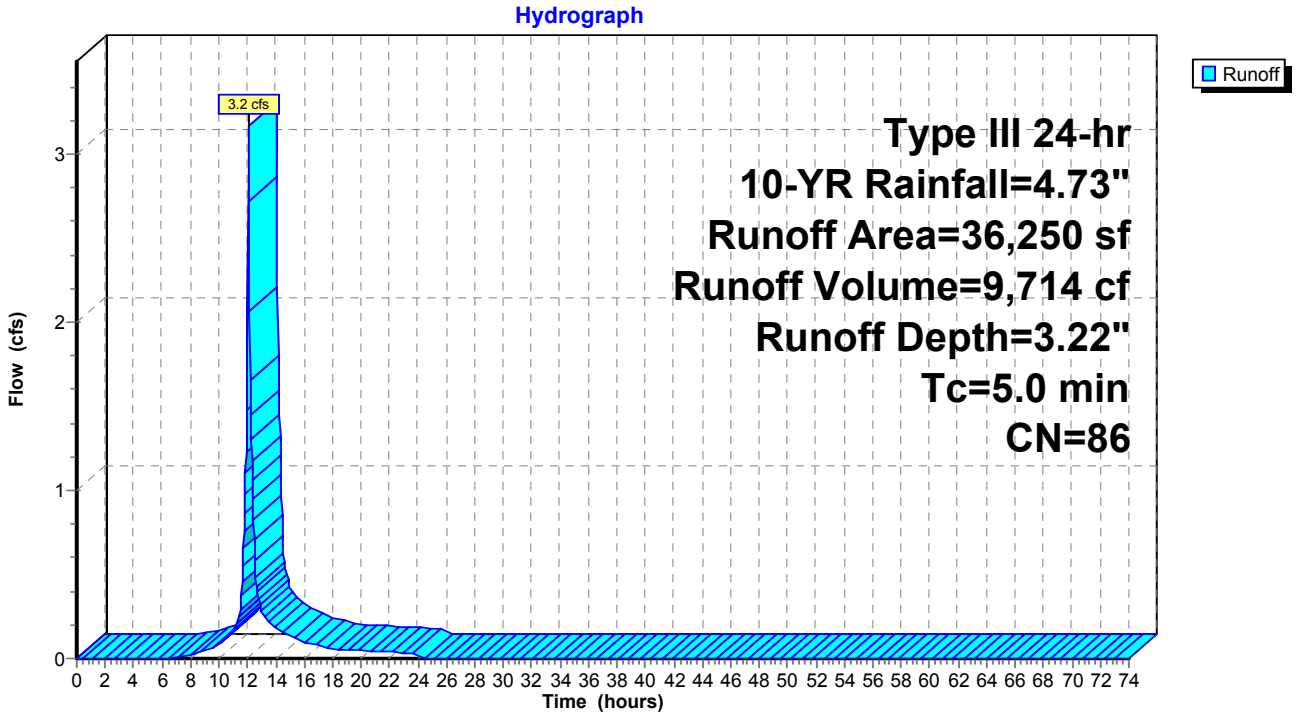
Runoff = 3.2 cfs @ 12.08 hrs, Volume= 9,714 cf, Depth= 3.22"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Type III 24-hr 10-YR Rainfall=4.73"

Area (sf)	CN	Description
28,950	98	Paved parking, HSG A
7,300	39	>75% Grass cover, Good, HSG A
36,250	86	Weighted Average
7,300		20.14% Pervious Area
28,950		79.86% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 30: Subcatchment 30



Summary for Subcatchment 40: Subcatchment 40

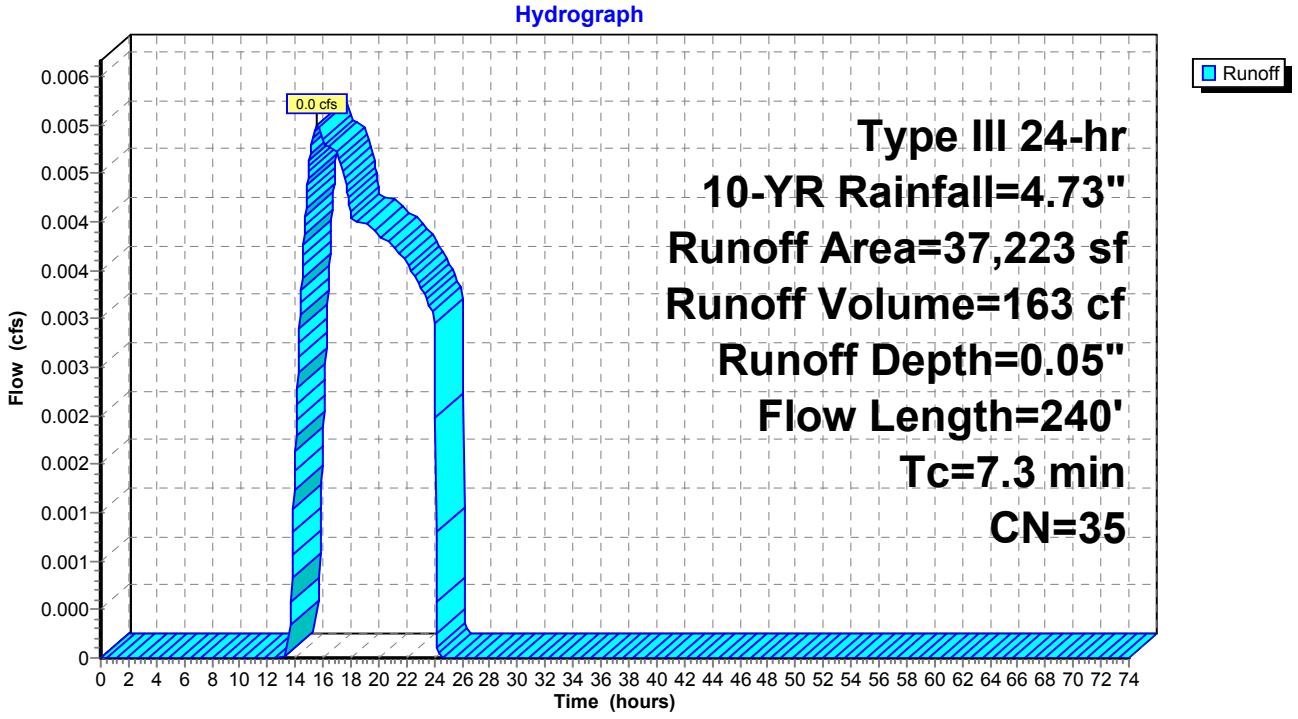
Runoff = 0.0 cfs @ 15.60 hrs, Volume= 163 cf, Depth= 0.05"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Type III 24-hr 10-YR Rainfall=4.73"

Area (sf)	CN	Description
18,876	39	>75% Grass cover, Good, HSG A
18,347	30	Woods, Good, HSG A
37,223	35	Weighted Average
37,223		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	20	0.3000	0.35		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.00"
3.3	30	0.0300	0.15		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.00"
2.4	114	0.0130	0.80		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.7	76	0.0130	1.71		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
7.3	240	Total			

Subcatchment 40: Subcatchment 40



Summary for Subcatchment 50: Subcatchment 50

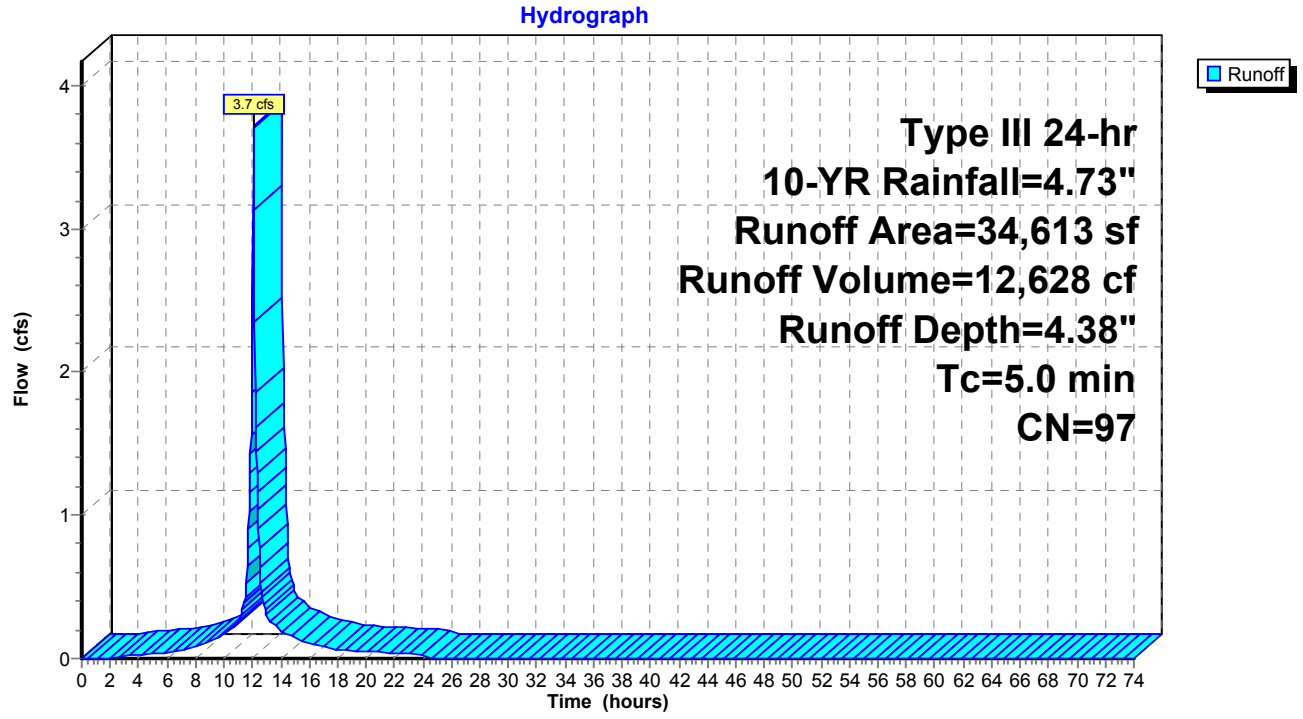
Runoff = 3.7 cfs @ 12.07 hrs, Volume= 12,628 cf, Depth= 4.38"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Type III 24-hr 10-YR Rainfall=4.73"

Area (sf)	CN	Description
33,995	98	Paved parking, HSG A
618	39	>75% Grass cover, Good, HSG A
34,613	97	Weighted Average
618		1.79% Pervious Area
33,995		98.21% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 50: Subcatchment 50



Summary for Pond 1P: Existing Pond - South

Inflow Area = 203,299 sf, 76.18% Impervious, Inflow Depth = 3.04" for 10-YR event
Inflow = 17.7 cfs @ 12.08 hrs, Volume= 51,508 cf
Outflow = 13.1 cfs @ 12.15 hrs, Volume= 51,508 cf, Atten= 26%, Lag= 4.2 min
Primary = 0.0 cfs @ 0.00 hrs, Volume= 0 cf
Secondary = 13.1 cfs @ 12.15 hrs, Volume= 51,508 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Starting Elev= 155.00' Surf.Area= 7,687 sf Storage= 16,436 cf
Peak Elev= 155.83' @ 12.15 hrs Surf.Area= 8,490 sf Storage= 23,181 cf (6,745 cf above start)

Plug-Flow detention time= 163.9 min calculated for 35,054 cf (68% of inflow)
Center-of-Mass det. time= 17.0 min (819.1 - 802.1)

Volume	Invert	Avail.Storage	Storage Description
#1	152.00'	49,544 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

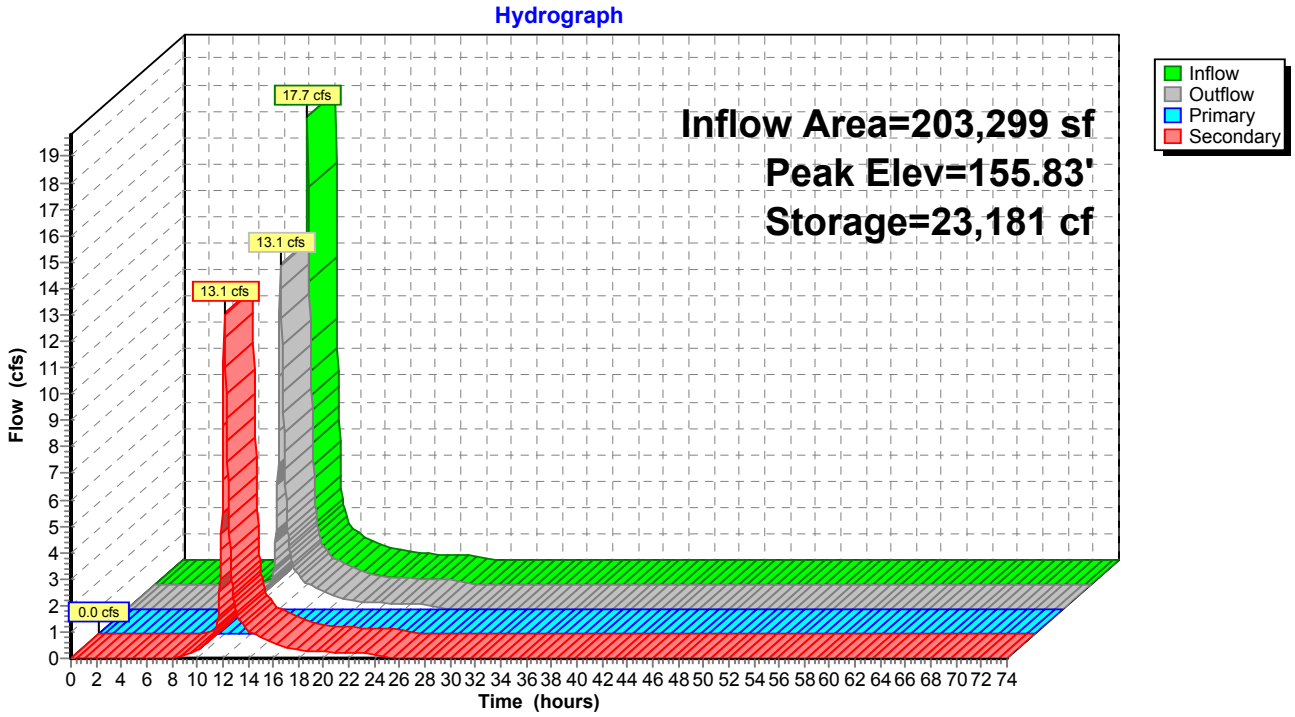
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
152.00	3,444	0	0
153.00	4,709	4,077	4,077
154.00	6,161	5,435	9,512
155.00	7,687	6,924	16,436
156.00	8,650	8,169	24,604
157.00	9,657	9,154	33,758
158.00	10,747	10,202	43,960
158.50	11,591	5,585	49,544

Device	Routing	Invert	Outlet Devices
#1	Primary	155.90'	**30.0" Round Culvert** L= 7.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 155.90' / 153.90' S= 0.2857 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 4.91 sf
#2	Device 1	154.10'	**4.0" Vert. Orifice** C= 0.600
#3	Device 1	155.30'	**45.0 deg Sharp-Crested Vee/Trap Weir** Cv= 2.56 (C= 3.20)
#4	Device 1	158.31'	**48.0" x 48.0" Horiz. Grate** C= 0.600 Limited to weir flow at low heads
#5	Secondary	155.00'	**6.5' long x 20.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=0.0 cfs @ 0.00 hrs HW=155.00' TW=0.00' (Dynamic Tailwater)
- **1=Culvert** (Controls 0.0 cfs)
  - **2=Orifice** (Controls 0.0 cfs)
  - **3=Sharp-Crested Vee/Trap Weir** (Controls 0.0 cfs)
  - **4=Grate** (Controls 0.0 cfs)

Secondary OutFlow Max=12.9 cfs @ 12.15 hrs HW=155.83' TW=0.00' (Dynamic Tailwater)
- **5=Broad-Crested Rectangular Weir** (Weir Controls 12.9 cfs @ 2.40 fps)

Pond 1P: Existing Pond - South



Summary for Pond 2P: Subsurface Basin

[87] Warning: Oscillations may require smaller dt or Finer Routing (severity=71)

Inflow Area =	36,250 sf,	79.86% Impervious,	Inflow Depth =	3.22" for 10-YR event
Inflow =	3.2 cfs @	12.08 hrs, Volume=	9,714 cf	
Outflow =	0.9 cfs @	12.41 hrs, Volume=	9,715 cf,	Atten= 71%, Lag= 19.8 min
Discarded =	0.2 cfs @	12.41 hrs, Volume=	7,406 cf	
Primary =	0.7 cfs @	12.41 hrs, Volume=	2,309 cf	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Peak Elev= 161.22' @ 12.41 hrs Surf.Area= 3,898 sf Storage= 2,910 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 55.7 min (861.4 - 805.6)

Volume	Invert	Avail.Storage	Storage Description
#1A	160.00'	2,726 cf	**38.17'W x 102.12'L x 2.33'H Field A** 9,094 cf Overall - 2,280 cf Embedded = 6,814 cf x 40.0% Voids
#2A	160.50'	2,280 cf	**ADS_StormTech SC-310** x 154 Inside #1 Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap Row Length Adjustment= +0.44' x 2.07 sf x 11 rows
		5,006 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	160.00'	**2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 0.00'
#2	Primary	162.30'	**3.7' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#3	Primary	160.70'	**8.0" Vert. Orifice/Grate** C= 0.600
#4	Primary	161.50'	**8.0" Vert. Orifice/Grate** C= 0.600

Discarded OutFlow Max=0.2 cfs @ 12.41 hrs HW=161.22' (Free Discharge)
└**1=Exfiltration** (Controls 0.2 cfs)

Primary OutFlow Max=0.7 cfs @ 12.41 hrs HW=161.22' TW=0.00' (Dynamic Tailwater)
├**2=Broad-Crested Rectangular Weir** (Controls 0.0 cfs)
├**3=Orifice/Grate** (Orifice Controls 0.7 cfs @ 2.45 fps)
└**4=Orifice/Grate** (Controls 0.0 cfs)

Pond 2P: Subsurface Basin - Chamber Wizard Field A

Chamber Model = ADS_StormTechSC-310 (ADS StormTech® SC-310)
Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf
Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap
Row Length Adjustment= +0.44' x 2.07 sf x 11 rows

34.0" Wide + 6.0" Spacing = 40.0" C-C Row Spacing

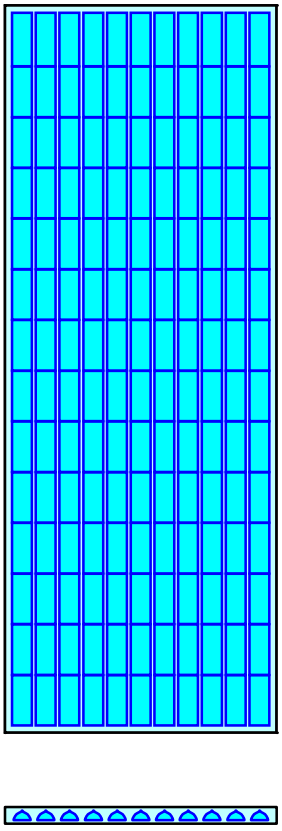
14 Chambers/Row x 7.12' Long +0.44' Row Adjustment = 100.12' Row Length +12.0" End Stone x 2 = 102.12' Base Length
11 Rows x 34.0" Wide + 6.0" Spacing x 10 + 12.0" Side Stone x 2 = 38.17' Base Width
6.0" Base + 16.0" Chamber Height + 6.0" Cover = 2.33' Field Height

154 Chambers x 14.7 cf +0.44' Row Adjustment x 2.07 sf x 11 Rows = 2,280.2 cf Chamber Storage

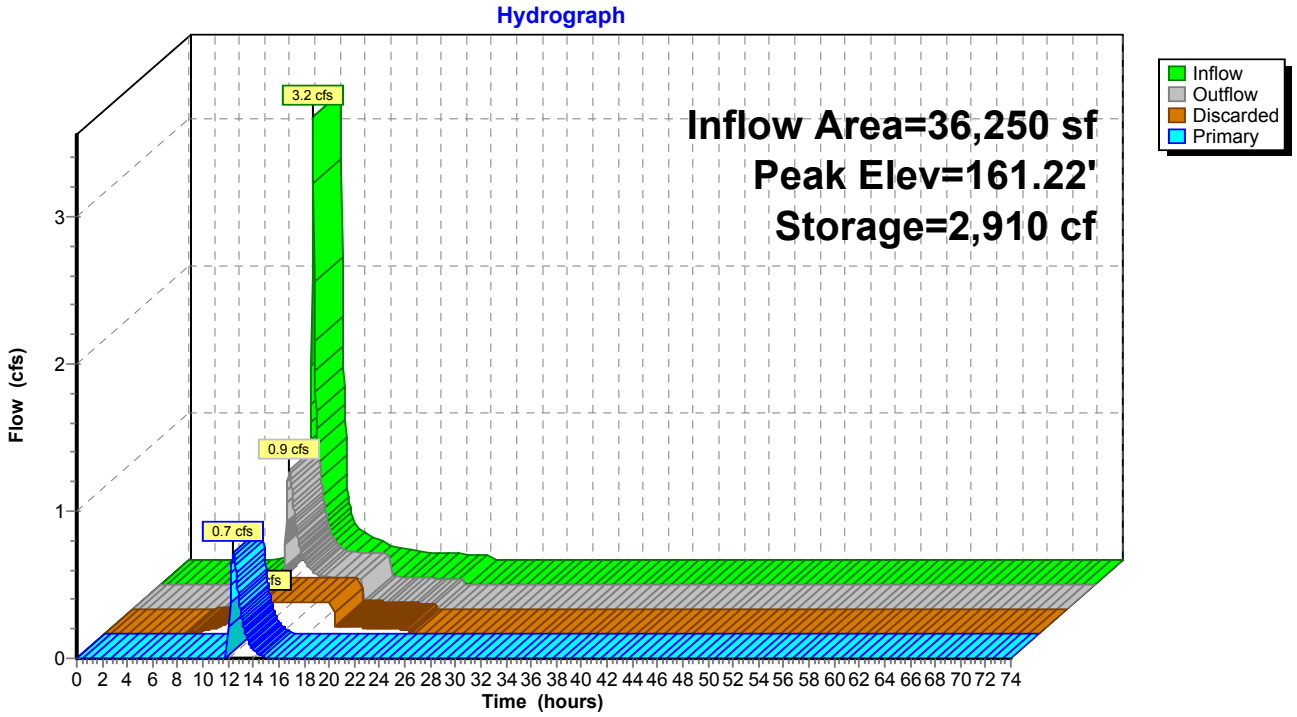
9,094.2 cf Field - 2,280.2 cf Chambers = 6,814.0 cf Stone x 40.0% Voids = 2,725.6 cf Stone Storage

Chamber Storage + Stone Storage = 5,005.8 cf = 0.1 af
Overall Storage Efficiency = 55.0%

154 Chambers
336.8 cy Field
252.4 cy Stone



Pond 2P: Subsurface Basin



Summary for Pond 3P: Subsurface Infiltration #2

[93] Warning: Storage range exceeded by 0.42'
[90] Warning: Qout>Qin may require smaller dt or Finer Routing
[87] Warning: Oscillations may require smaller dt or Finer Routing (severity=55)

Inflow Area =	33,518 sf,	100.00% Impervious,	Inflow Depth =	4.49"	for 10-YR event
Inflow =	3.6 cfs @	12.07 hrs,	Volume=	12,551 cf	
Outflow =	3.7 cfs @	12.07 hrs,	Volume=	12,553 cf,	Atten= 0%, Lag= 0.1 min
Discarded =	0.0 cfs @	12.07 hrs,	Volume=	3,836 cf	
Primary =	3.6 cfs @	12.07 hrs,	Volume=	8,717 cf	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Peak Elev= 159.25' @ 12.07 hrs Surf.Area= 691 sf Storage= 869 cf

Plug-Flow detention time= 75.5 min calculated for 12,546 cf (100% of inflow)
Center-of-Mass det. time= 75.8 min (823.8 - 748.0)

Volume	Invert	Avail.Storage	Storage Description
#1A	156.50'	496 cf	**18.17'W x 38.04'L x 2.33'H Field A** 1,612 cf Overall - 373 cf Embedded = 1,239 cf x 40.0% Voids
#2A	157.00'	373 cf	**ADS_StormTech SC-310** x 25 Inside #1 Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap Row Length Adjustment= +0.44' x 2.07 sf x 5 rows
		869 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	156.50'	**2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 0.00'
#2	Primary	158.80'	**4.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Discarded OutFlow Max=0.0 cfs @ 12.07 hrs HW=159.25' (Free Discharge)
1=Exfiltration (Controls 0.0 cfs)

Primary OutFlow Max=3.6 cfs @ 12.07 hrs HW=159.25' TW=155.73' (Dynamic Tailwater)
2=Broad-Crested Rectangular Weir (Weir Controls 3.6 cfs @ 1.98 fps)

Pond 3P: Subsurface Infiltration #2 - Chamber Wizard Field A

Chamber Model = ADS_StormTechSC-310 (ADS StormTech® SC-310)
Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf
Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap
Row Length Adjustment= +0.44' x 2.07 sf x 5 rows

34.0" Wide + 6.0" Spacing = 40.0" C-C Row Spacing

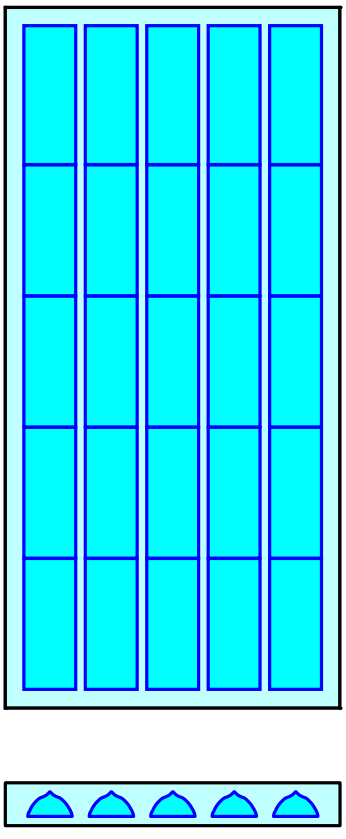
5 Chambers/Row x 7.12' Long +0.44' Row Adjustment = 36.04' Row Length +12.0" End Stone x 2 = 38.04' Base Length
5 Rows x 34.0" Wide + 6.0" Spacing x 4 + 12.0" Side Stone x 2 = 18.17' Base Width
6.0" Base + 16.0" Chamber Height + 6.0" Cover = 2.33' Field Height

25 Chambers x 14.7 cf +0.44' Row Adjustment x 2.07 sf x 5 Rows = 373.1 cf Chamber Storage

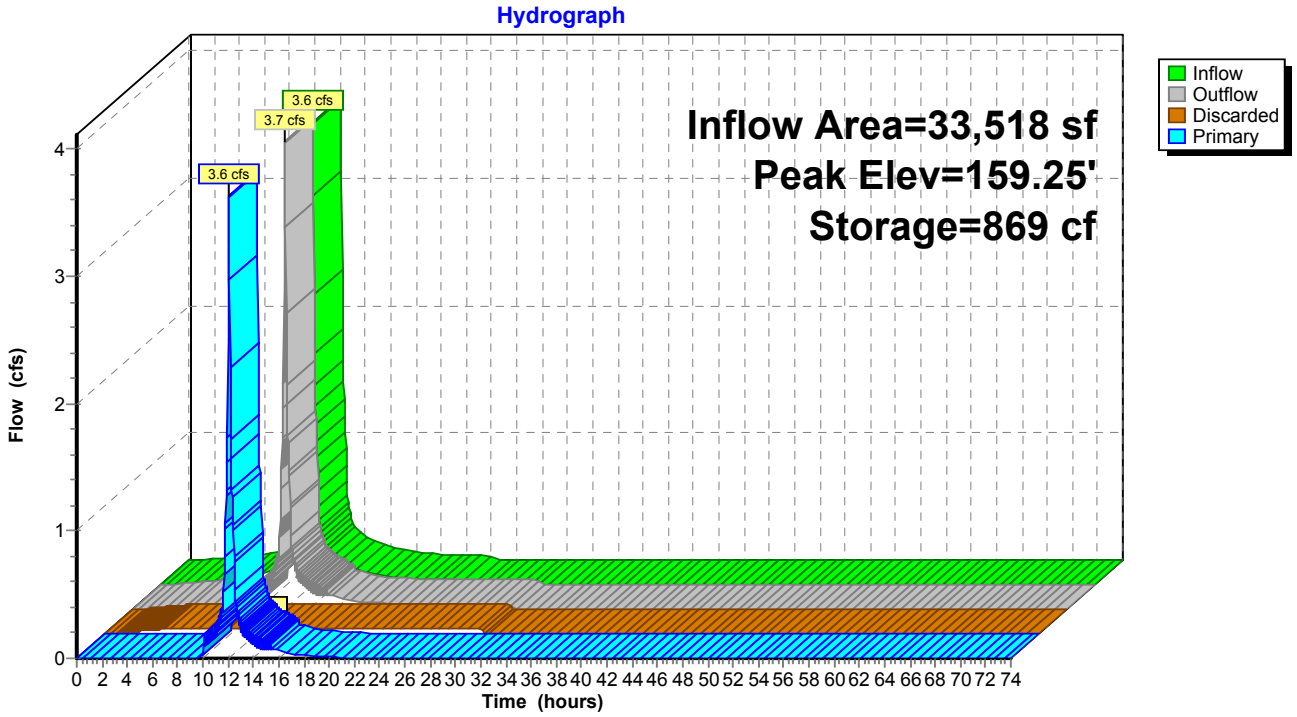
1,612.4 cf Field - 373.1 cf Chambers = 1,239.3 cf Stone x 40.0% Voids = 495.7 cf Stone Storage

Chamber Storage + Stone Storage = 868.8 cf = 0.0 af
Overall Storage Efficiency = 53.9%

25 Chambers
59.7 cy Field
45.9 cy Stone



Pond 3P: Subsurface Infiltration #2

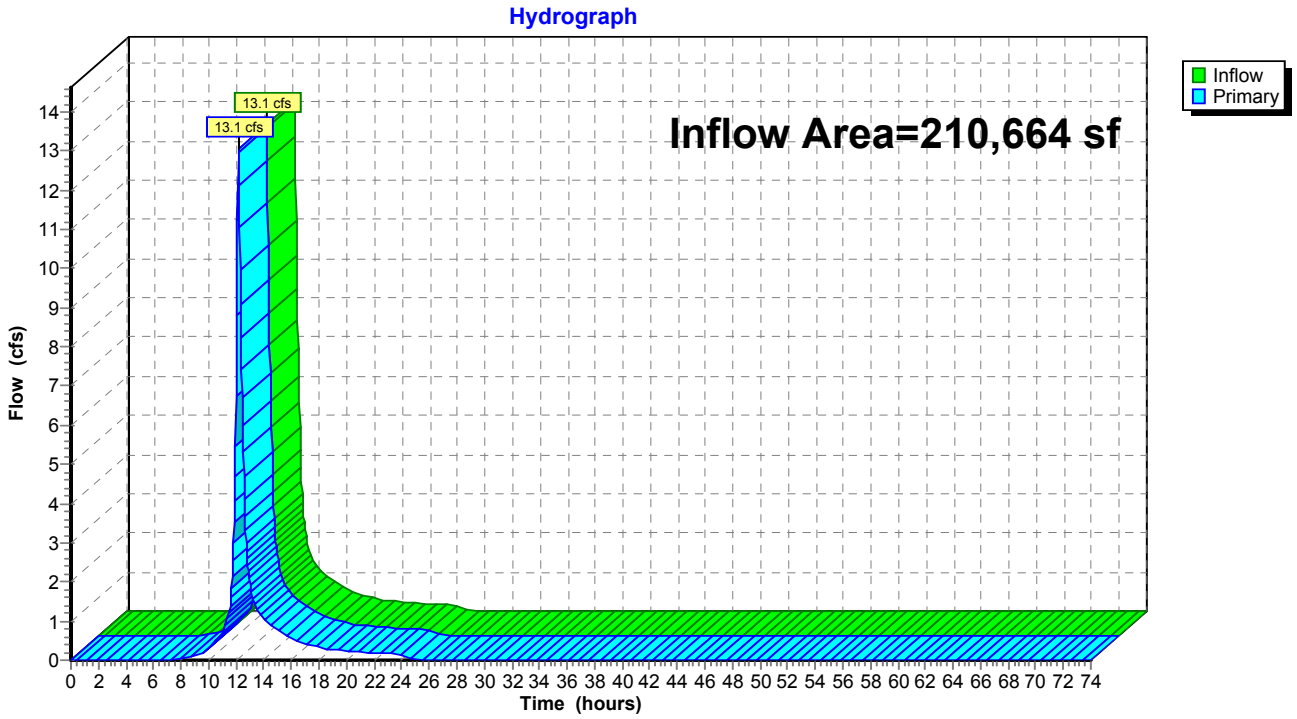


Summary for Link DP 1: South - Wetland

Inflow Area = 210,664 sf, 73.51% Impervious, Inflow Depth = 2.94" for 10-YR event
Inflow = 13.1 cfs @ 12.15 hrs, Volume= 51,599 cf
Primary = 13.1 cfs @ 12.15 hrs, Volume= 51,599 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs

Link DP 1: South - Wetland

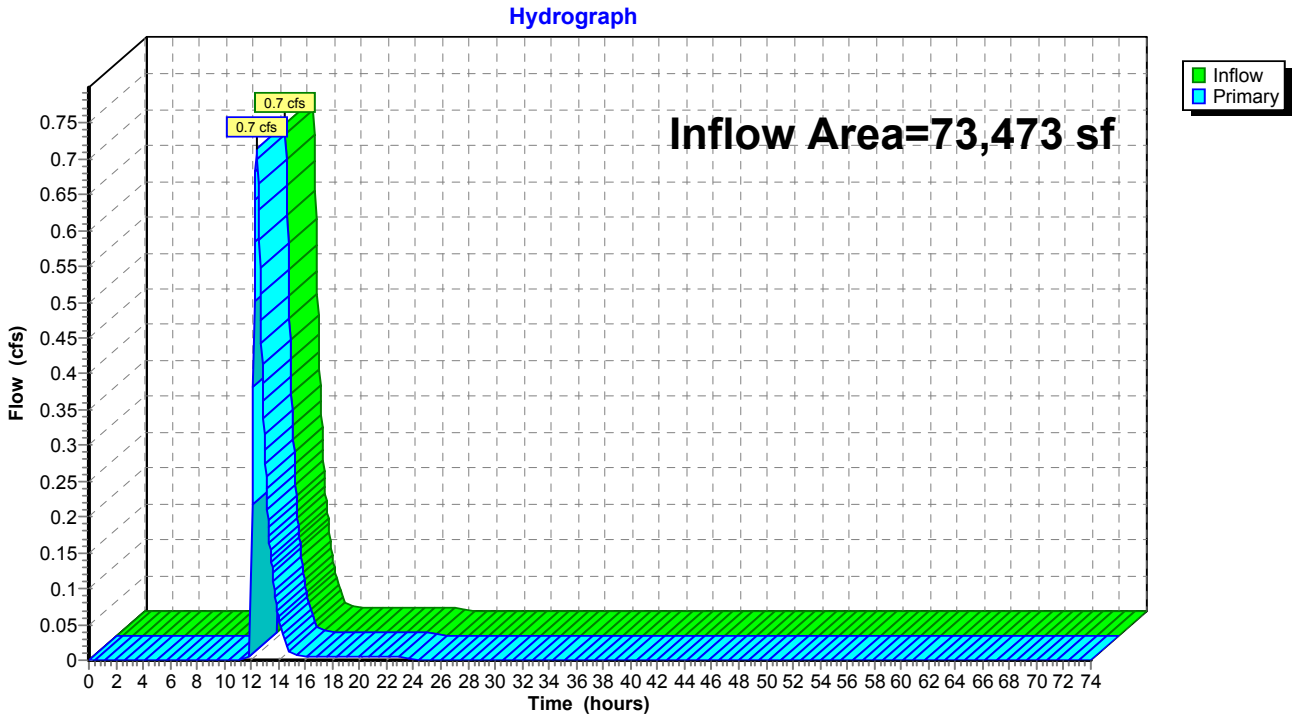


Summary for Link DP 2: North - Culvert

Inflow Area = 73,473 sf, 39.40% Impervious, Inflow Depth = 0.40" for 10-YR event
Inflow = 0.7 cfs @ 12.41 hrs, Volume= 2,473 cf
Primary = 0.7 cfs @ 12.41 hrs, Volume= 2,473 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs

Link DP 2: North - Culvert

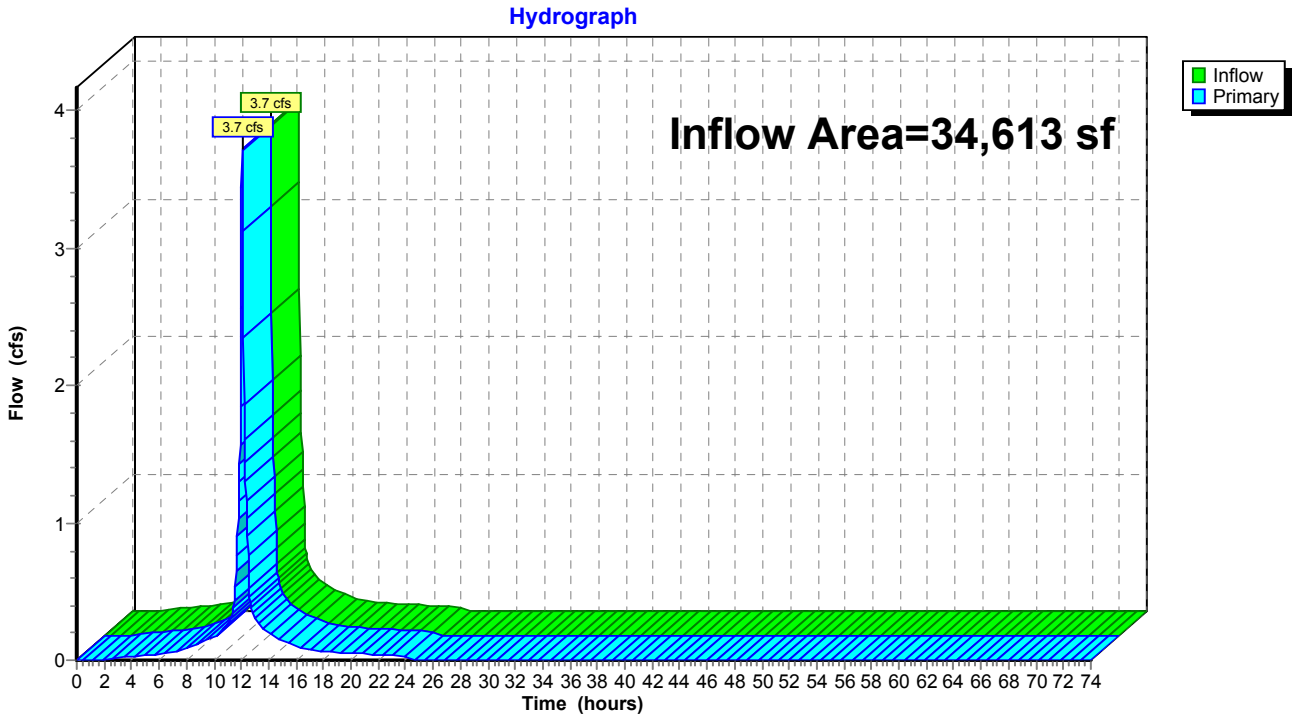


Summary for Link DP 3: Shoppers World Drive

Inflow Area = 34,613 sf, 98.21% Impervious, Inflow Depth = 4.38" for 10-YR event
Inflow = 3.7 cfs @ 12.07 hrs, Volume= 12,628 cf
Primary = 3.7 cfs @ 12.07 hrs, Volume= 12,628 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs

Link DP 3: Shoppers World Drive



25- Year-Storm-Event-Proposed

Summary for Subcatchment 10: Subcatchment 10

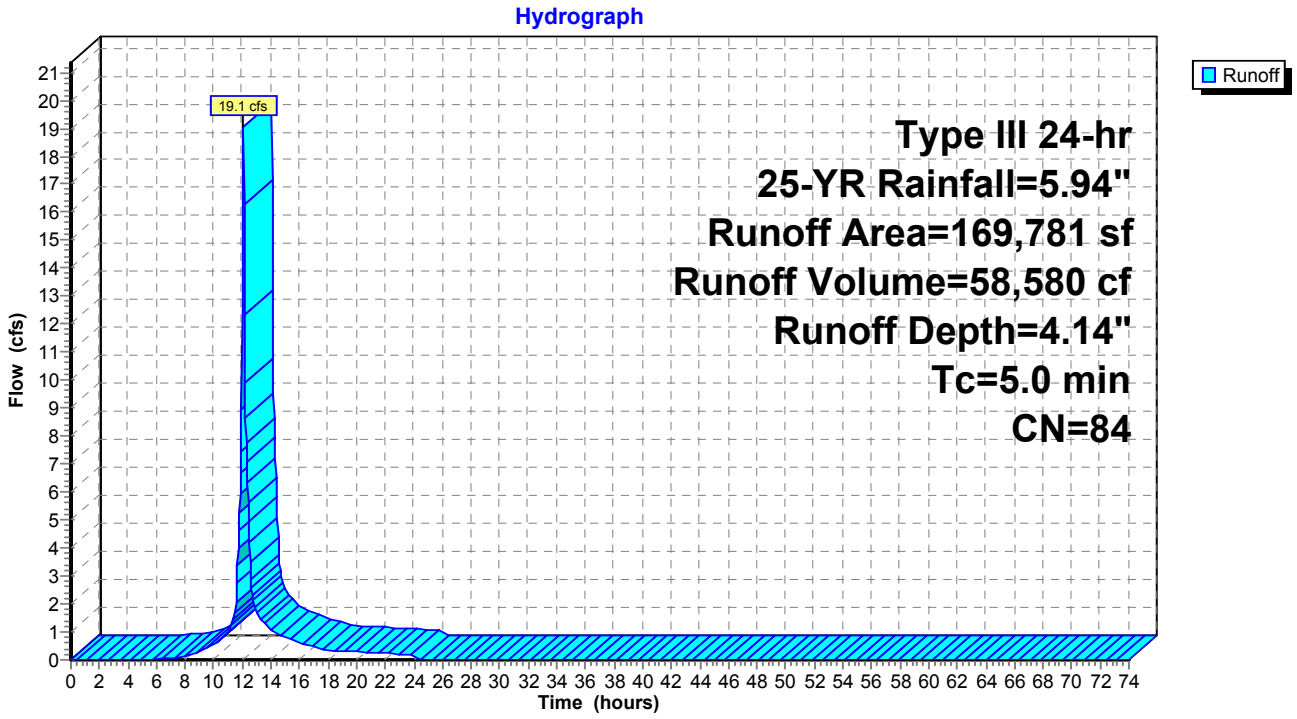
Runoff = 19.1 cfs @ 12.08 hrs, Volume= 58,580 cf, Depth= 4.14"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Type III 24-hr 25-YR Rainfall=5.94"

Area (sf)	CN	Description
121,346	98	Paved parking, HSG A
6,895	98	Water Surface, 0% imp, HSG A
140	98	Water Surface, 0% imp, HSG D
39,600	39	>75% Grass cover, Good, HSG A
1,800	80	>75% Grass cover, Good, HSG D
169,781	84	Weighted Average
48,435		28.53% Pervious Area
121,346		71.47% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 10: Subcatchment 10



Summary for Subcatchment 11A: Roof (Kings)

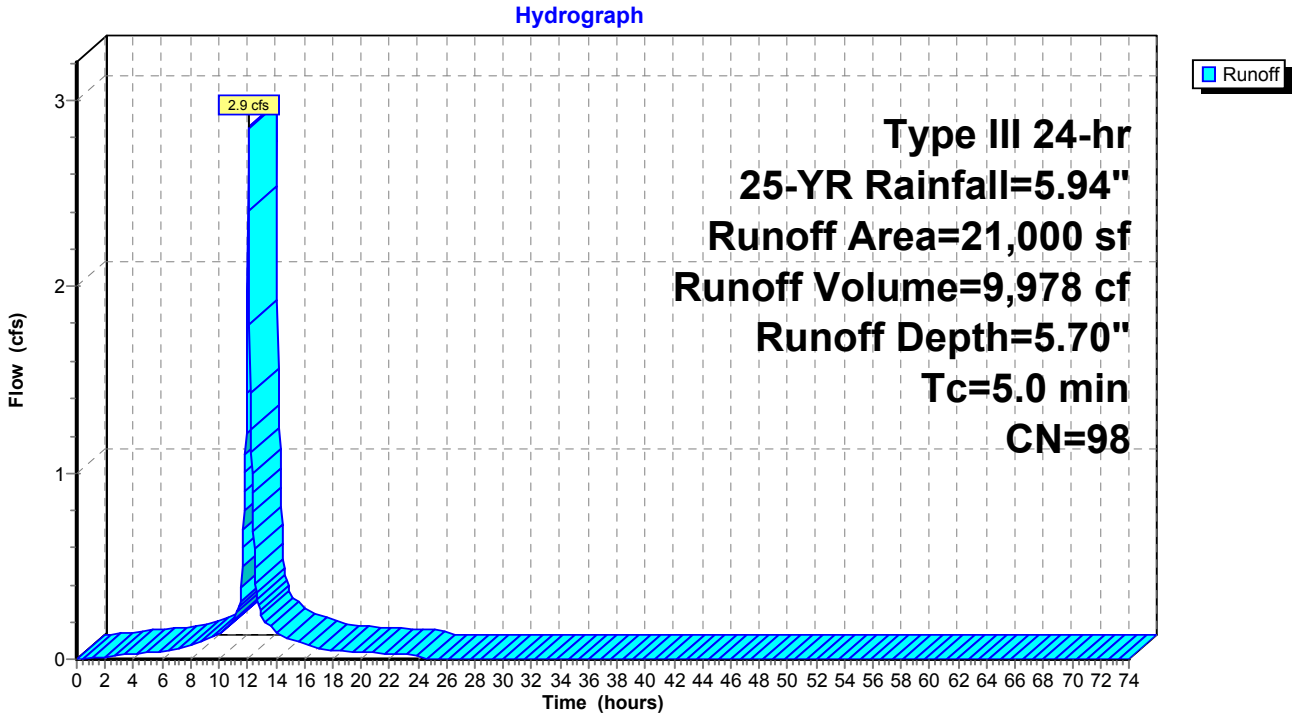
Runoff = 2.9 cfs @ 12.07 hrs, Volume= 9,978 cf, Depth= 5.70"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Type III 24-hr 25-YR Rainfall=5.94"

Area (sf)	CN	Description
21,000	98	Roofs, HSG A
21,000		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 11A: Roof (Kings)



Summary for Subcatchment 11B: Roof (Restaurant)

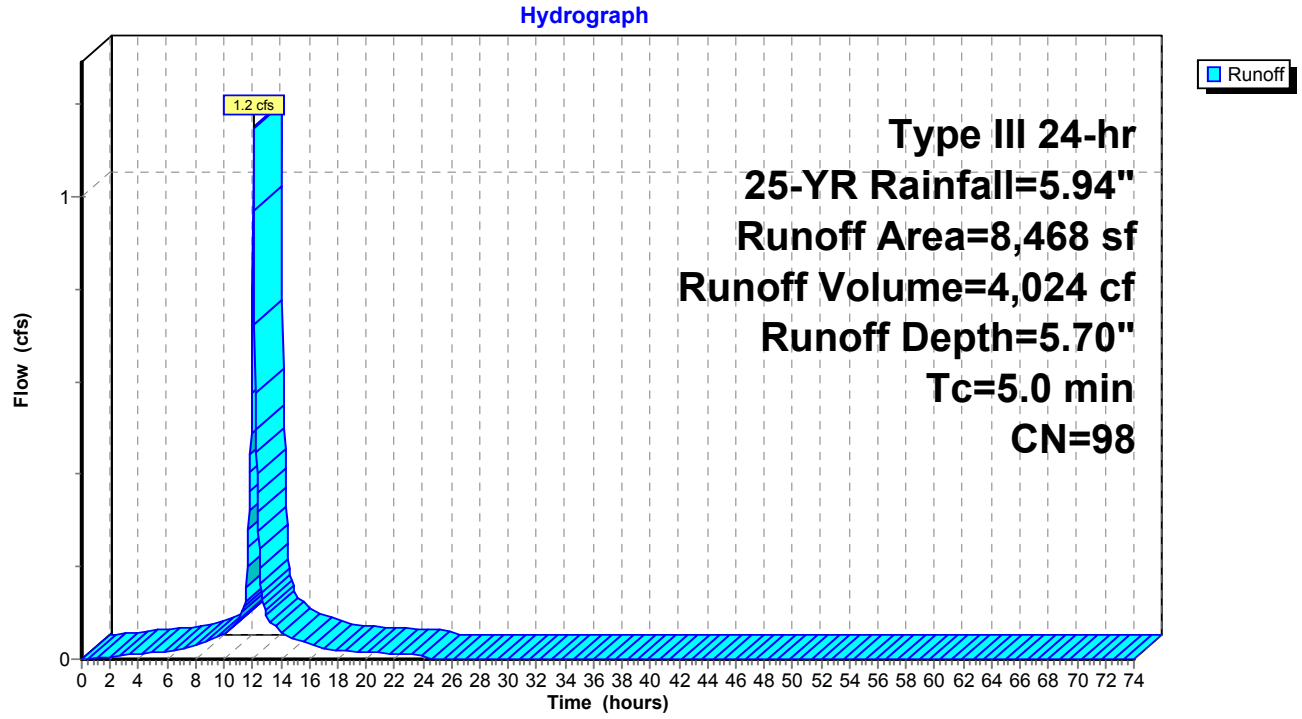
Runoff = 1.2 cfs @ 12.07 hrs, Volume= 4,024 cf, Depth= 5.70"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Type III 24-hr 25-YR Rainfall=5.94"

Area (sf)	CN	Description
8,468	98	Roofs, HSG A
8,468		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 11B: Roof (Restaurant)



Summary for Subcatchment 11C: Roof (lfly,)

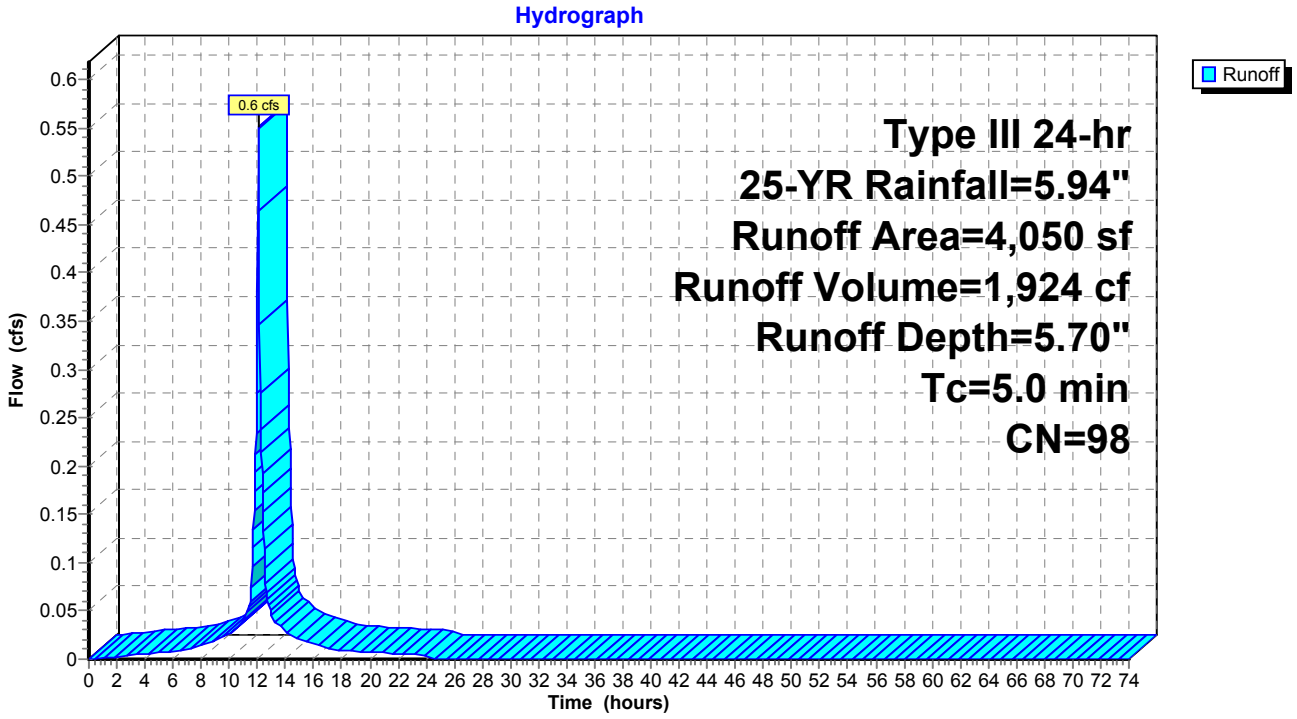
Runoff = 0.6 cfs @ 12.07 hrs, Volume= 1,924 cf, Depth= 5.70"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Type III 24-hr 25-YR Rainfall=5.94"

Area (sf)	CN	Description
4,050	98	Roofs, HSG A
4,050		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 11C: Roof (lfly,)



Summary for Subcatchment 20: Subcatchment 20

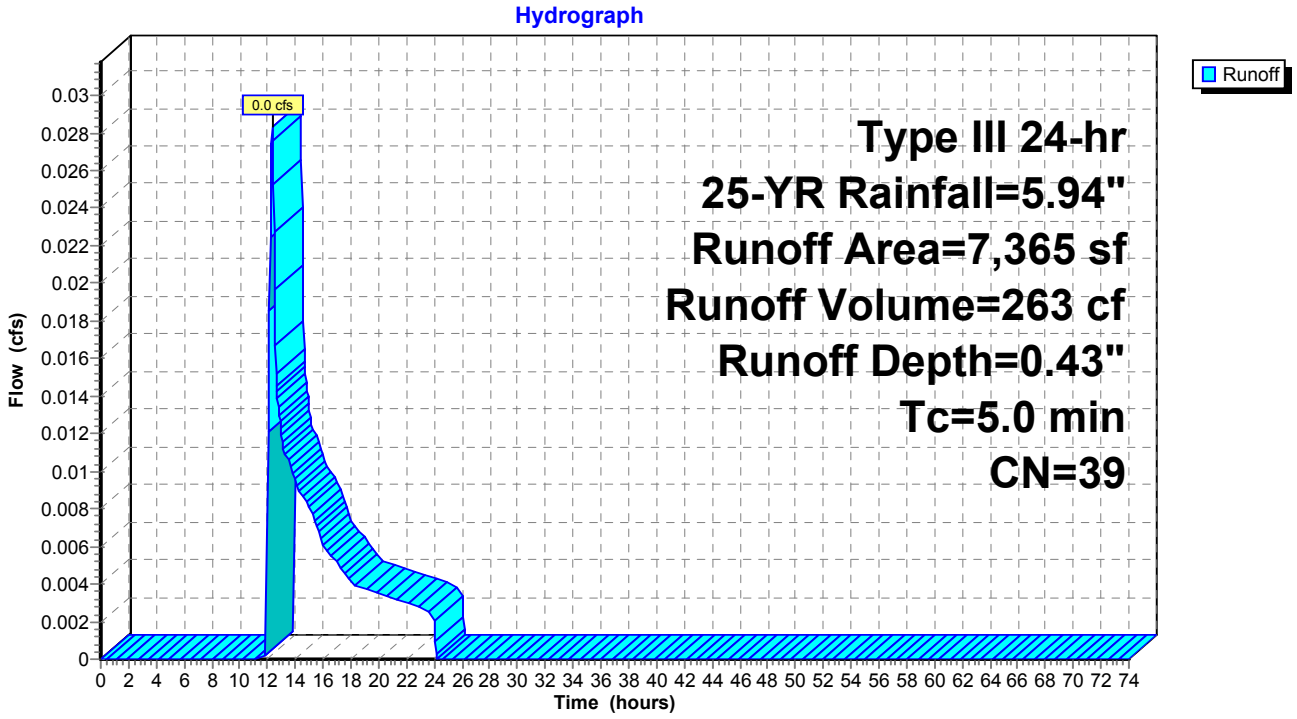
Runoff = 0.0 cfs @ 12.33 hrs, Volume= 263 cf, Depth= 0.43"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Type III 24-hr 25-YR Rainfall=5.94"

Area (sf)	CN	Description
7,365	39	>75% Grass cover, Good, HSG A
7,365		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 20: Subcatchment 20



Summary for Subcatchment 30: Subcatchment 30

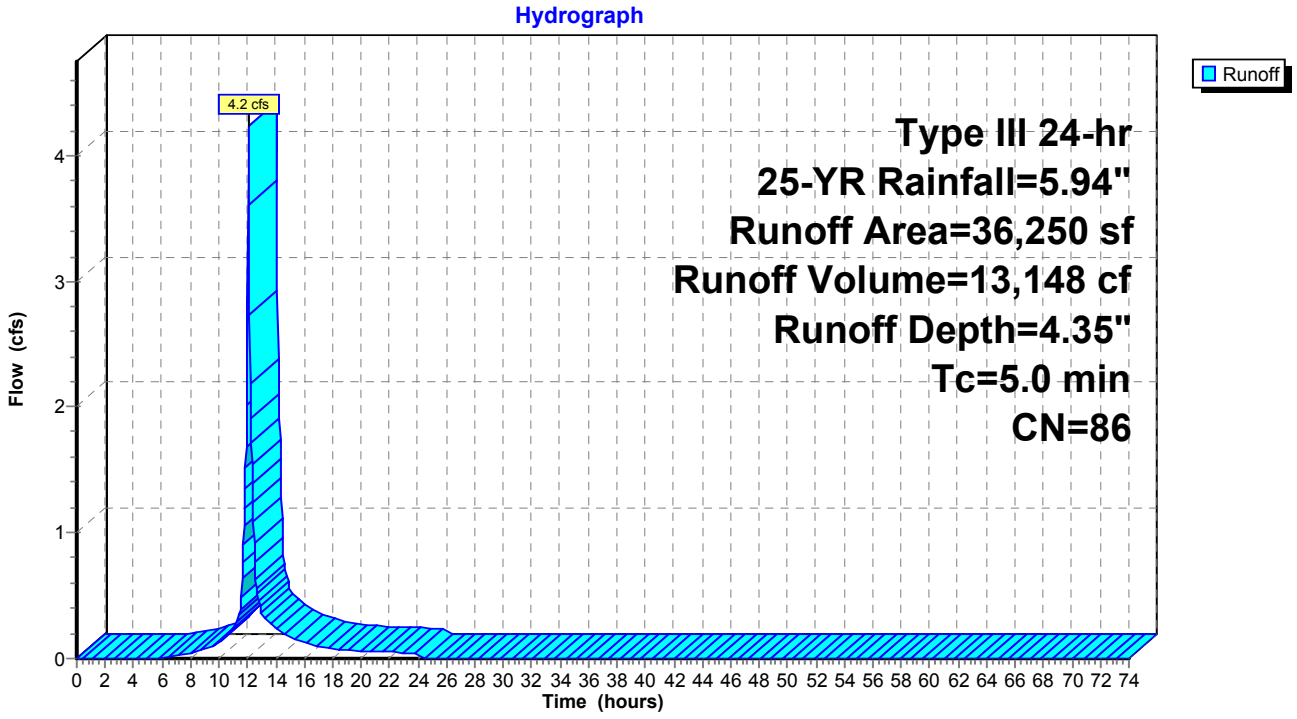
Runoff = 4.2 cfs @ 12.07 hrs, Volume= 13,148 cf, Depth= 4.35"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Type III 24-hr 25-YR Rainfall=5.94"

Area (sf)	CN	Description
28,950	98	Paved parking, HSG A
7,300	39	>75% Grass cover, Good, HSG A
36,250	86	Weighted Average
7,300		20.14% Pervious Area
28,950		79.86% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 30: Subcatchment 30



Summary for Subcatchment 40: Subcatchment 40

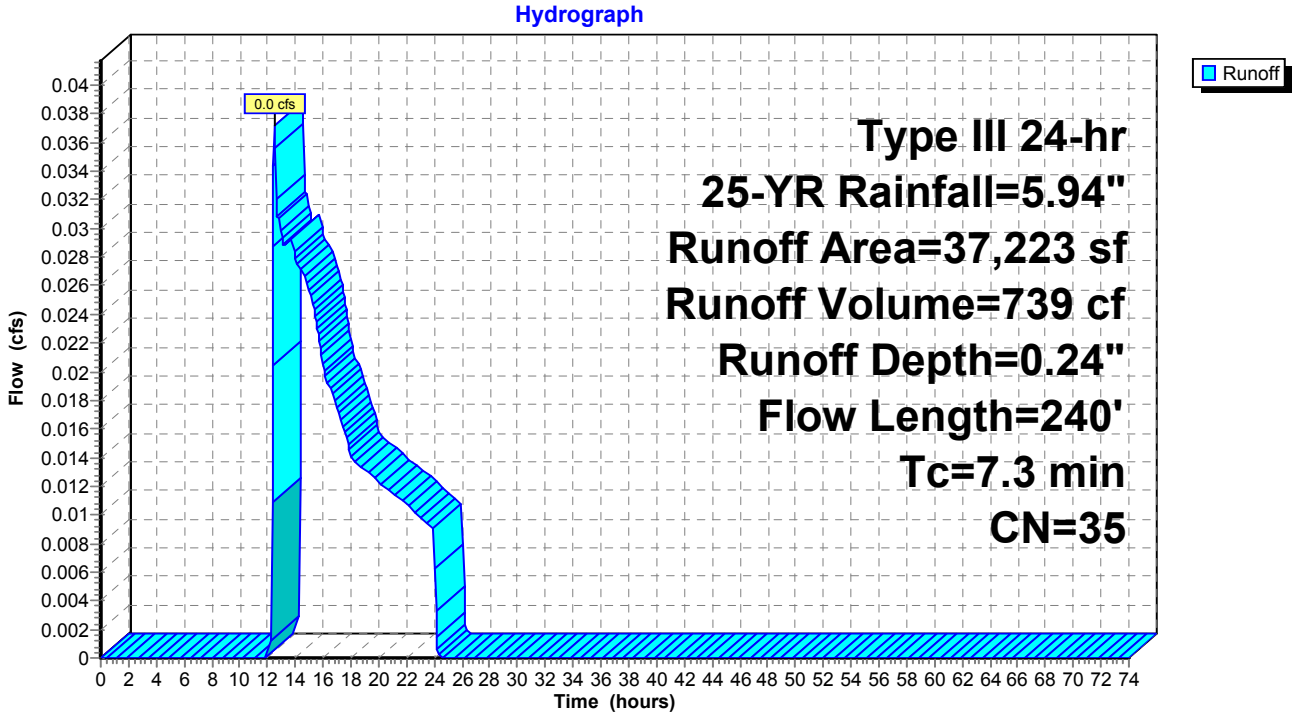
Runoff = 0.0 cfs @ 12.50 hrs, Volume= 739 cf, Depth= 0.24"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Type III 24-hr 25-YR Rainfall=5.94"

Area (sf)	CN	Description
18,876	39	>75% Grass cover, Good, HSG A
18,347	30	Woods, Good, HSG A
37,223	35	Weighted Average
37,223		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	20	0.3000	0.35		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.00"
3.3	30	0.0300	0.15		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.00"
2.4	114	0.0130	0.80		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.7	76	0.0130	1.71		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
7.3	240	Total			

Subcatchment 40: Subcatchment 40



Summary for Subcatchment 50: Subcatchment 50

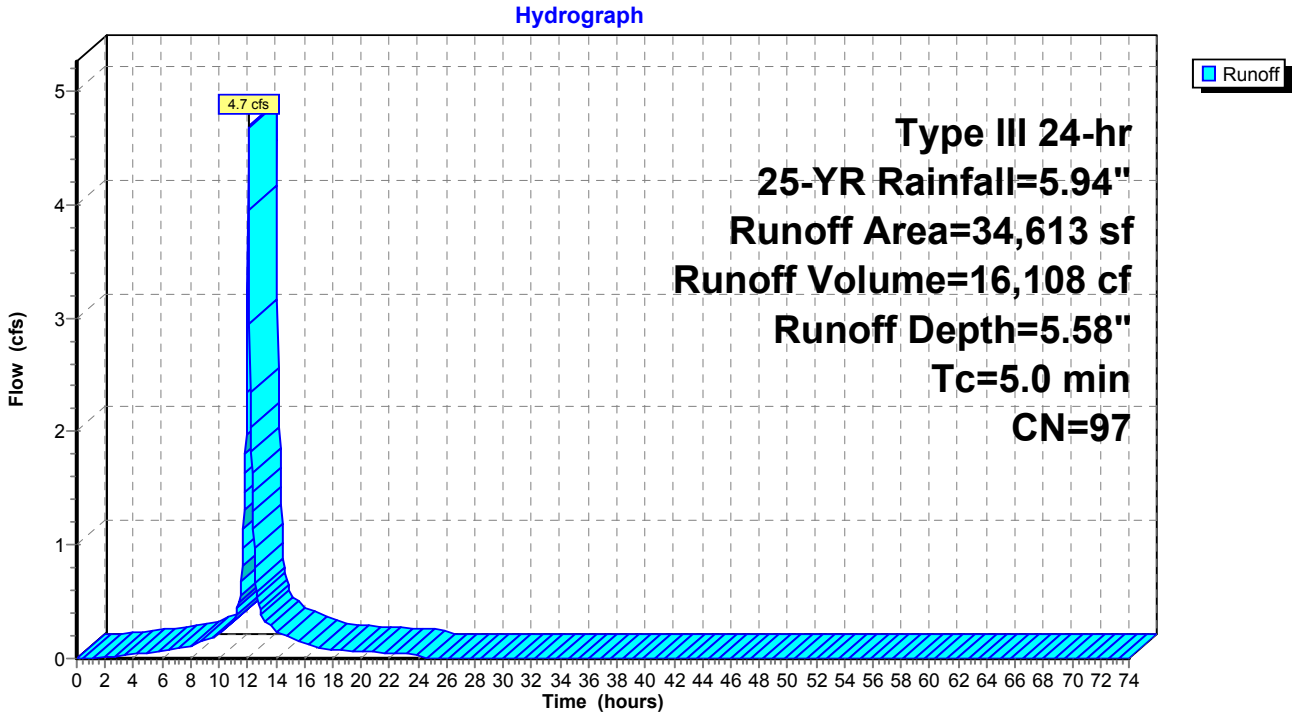
Runoff = 4.7 cfs @ 12.07 hrs, Volume= 16,108 cf, Depth= 5.58"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Type III 24-hr 25-YR Rainfall=5.94"

Area (sf)	CN	Description
33,995	98	Paved parking, HSG A
618	39	>75% Grass cover, Good, HSG A
34,613	97	Weighted Average
618		1.79% Pervious Area
33,995		98.21% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 50: Subcatchment 50



Summary for Pond 1P: Existing Pond - South

Inflow Area = 203,299 sf, 76.18% Impervious, Inflow Depth = 4.16" for 25-YR event
Inflow = 23.5 cfs @ 12.07 hrs, Volume= 70,537 cf
Outflow = 18.2 cfs @ 12.14 hrs, Volume= 70,537 cf, Atten= 23%, Lag= 3.8 min
Primary = 0.1 cfs @ 12.14 hrs, Volume= 38 cf
Secondary = 18.0 cfs @ 12.14 hrs, Volume= 70,499 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Starting Elev= 155.00' Surf.Area= 7,687 sf Storage= 16,436 cf
Peak Elev= 156.04' @ 12.14 hrs Surf.Area= 8,686 sf Storage= 24,917 cf (8,482 cf above start)

Plug-Flow detention time= 137.9 min calculated for 54,102 cf (77% of inflow)
Center-of-Mass det. time= 15.6 min (810.6 - 795.0)

Volume	Invert	Avail.Storage	Storage Description
#1	152.00'	49,544 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

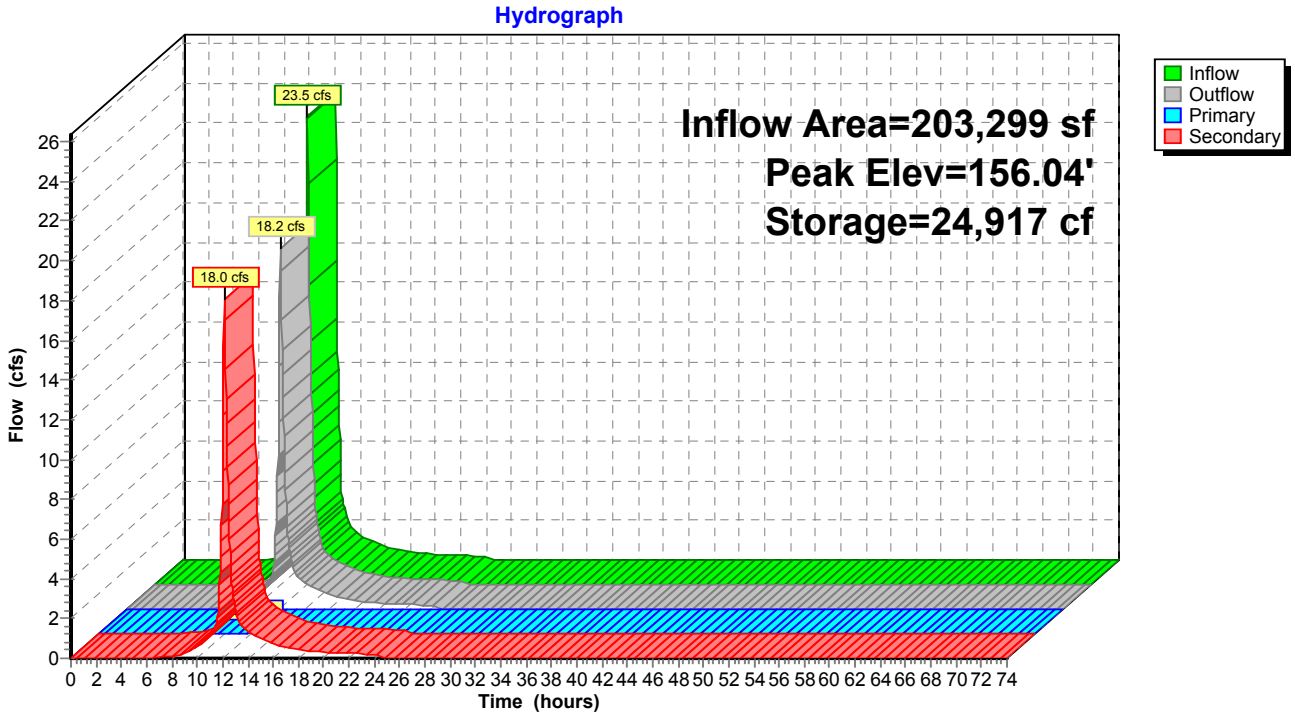
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
152.00	3,444	0	0
153.00	4,709	4,077	4,077
154.00	6,161	5,435	9,512
155.00	7,687	6,924	16,436
156.00	8,650	8,169	24,604
157.00	9,657	9,154	33,758
158.00	10,747	10,202	43,960
158.50	11,591	5,585	49,544

Device	Routing	Invert	Outlet Devices
#1	Primary	155.90'	**30.0" Round Culvert** L= 7.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 155.90' / 153.90' S= 0.2857 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 4.91 sf
#2	Device 1	154.10'	**4.0" Vert. Orifice** C= 0.600
#3	Device 1	155.30'	**45.0 deg Sharp-Crested Vee/Trap Weir** Cv= 2.56 (C= 3.20)
#4	Device 1	158.31'	**48.0" x 48.0" Horiz. Grate** C= 0.600 Limited to weir flow at low heads
#5	Secondary	155.00'	**6.5' long x 20.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=0.1 cfs @ 12.14 hrs HW=156.03' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 0.1 cfs @ 1.21 fps)
  └─**2=Orifice** (Passes < 0.1 cfs potential flow)
  └─**3=Sharp-Crested Vee/Trap Weir** (Passes < 0.3 cfs potential flow)
  └─**4=Grate** (Controls 0.0 cfs)

Secondary OutFlow Max=17.8 cfs @ 12.14 hrs HW=156.03' TW=0.00' (Dynamic Tailwater)
└─**5=Broad-Crested Rectangular Weir** (Weir Controls 17.8 cfs @ 2.66 fps)

Pond 1P: Existing Pond - South



Summary for Pond 2P: Subsurface Basin

[87] Warning: Oscillations may require smaller dt or Finer Routing (severity=61)

Inflow Area = 36,250 sf, 79.86% Impervious, Inflow Depth = 4.35" for 25-YR event
Inflow = 4.2 cfs @ 12.07 hrs, Volume= 13,148 cf
Outflow = 1.5 cfs @ 12.34 hrs, Volume= 13,153 cf, Atten= 65%, Lag= 16.0 min
Discarded = 0.2 cfs @ 12.34 hrs, Volume= 8,702 cf
Primary = 1.2 cfs @ 12.34 hrs, Volume= 4,451 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Peak Elev= 161.57' @ 12.34 hrs Surf.Area= 3,898 sf Storage= 3,759 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 52.7 min (849.9 - 797.1)

Volume	Invert	Avail.Storage	Storage Description
#1A	160.00'	2,726 cf	**38.17'W x 102.12'L x 2.33'H Field A** 9,094 cf Overall - 2,280 cf Embedded = 6,814 cf x 40.0% Voids
#2A	160.50'	2,280 cf	**ADS_StormTech SC-310** x 154 Inside #1 Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap Row Length Adjustment= +0.44' x 2.07 sf x 11 rows
		5,006 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	160.00'	**2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 0.00'
#2	Primary	162.30'	**3.7' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#3	Primary	160.70'	**8.0" Vert. Orifice/Grate** C= 0.600
#4	Primary	161.50'	**8.0" Vert. Orifice/Grate** C= 0.600

Discarded OutFlow Max=0.2 cfs @ 12.34 hrs HW=161.57' (Free Discharge)
└**1=Exfiltration** (Controls 0.2 cfs)

Primary OutFlow Max=1.2 cfs @ 12.34 hrs HW=161.57' TW=0.00' (Dynamic Tailwater)
├**2=Broad-Crested Rectangular Weir** (Controls 0.0 cfs)
├**3=Orifice/Grate** (Orifice Controls 1.2 cfs @ 3.52 fps)
└**4=Orifice/Grate** (Orifice Controls 0.0 cfs @ 0.89 fps)

Pond 2P: Subsurface Basin - Chamber Wizard Field A

Chamber Model = ADS_StormTechSC-310 (ADS StormTech® SC-310)
Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf
Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap
Row Length Adjustment= +0.44' x 2.07 sf x 11 rows

34.0" Wide + 6.0" Spacing = 40.0" C-C Row Spacing

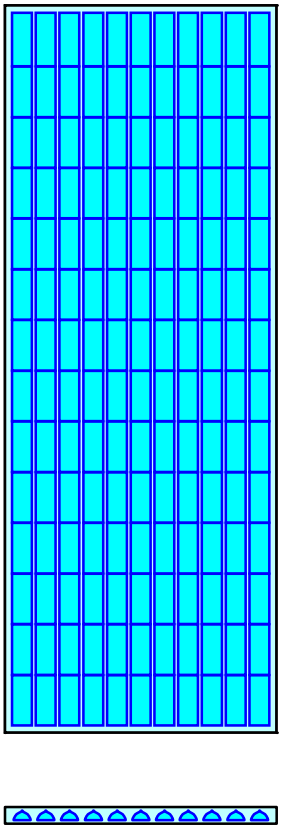
14 Chambers/Row x 7.12' Long +0.44' Row Adjustment = 100.12' Row Length +12.0" End Stone x 2 = 102.12' Base Length
11 Rows x 34.0" Wide + 6.0" Spacing x 10 + 12.0" Side Stone x 2 = 38.17' Base Width
6.0" Base + 16.0" Chamber Height + 6.0" Cover = 2.33' Field Height

154 Chambers x 14.7 cf +0.44' Row Adjustment x 2.07 sf x 11 Rows = 2,280.2 cf Chamber Storage

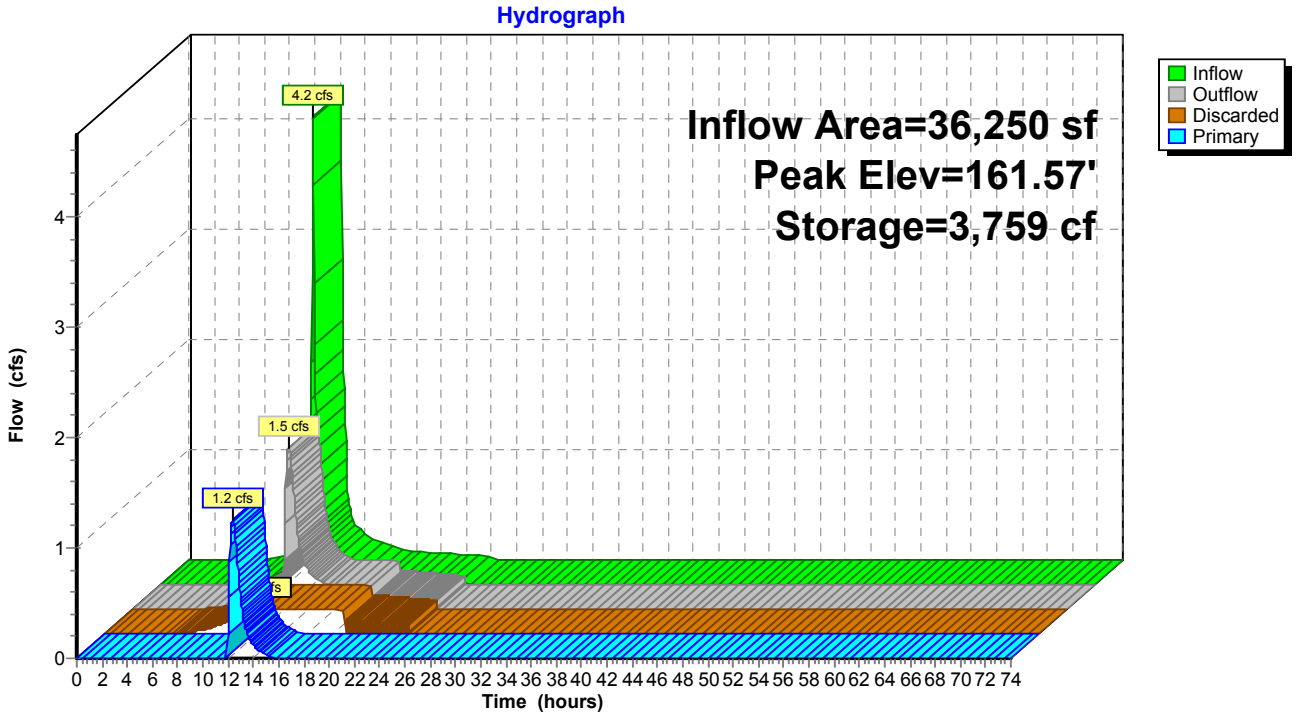
9,094.2 cf Field - 2,280.2 cf Chambers = 6,814.0 cf Stone x 40.0% Voids = 2,725.6 cf Stone Storage

Chamber Storage + Stone Storage = 5,005.8 cf = 0.1 af
Overall Storage Efficiency = 55.0%

154 Chambers
336.8 cy Field
252.4 cy Stone



Pond 2P: Subsurface Basin



Summary for Pond 3P: Subsurface Infiltration #2

[93] Warning: Storage range exceeded by 0.48'
[87] Warning: Oscillations may require smaller dt or Finer Routing (severity=73)

Inflow Area =	33,518 sf,	100.00% Impervious,	Inflow Depth =	5.70"	for 25-YR event
Inflow =	4.6 cfs @	12.07 hrs,	Volume=	15,926 cf	
Outflow =	4.5 cfs @	12.07 hrs,	Volume=	15,928 cf,	Atten= 1%, Lag= 0.0 min
Discarded =	0.0 cfs @	12.07 hrs,	Volume=	3,970 cf	
Primary =	4.5 cfs @	12.07 hrs,	Volume=	11,958 cf	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Peak Elev= 159.32' @ 12.07 hrs Surf.Area= 691 sf Storage= 869 cf

Plug-Flow detention time= 63.8 min calculated for 15,919 cf (100% of inflow)
Center-of-Mass det. time= 64.0 min (808.4 - 744.4)

Volume	Invert	Avail.Storage	Storage Description
#1A	156.50'	496 cf	**18.17'W x 38.04'L x 2.33'H Field A** 1,612 cf Overall - 373 cf Embedded = 1,239 cf x 40.0% Voids
#2A	157.00'	373 cf	**ADS_StormTech SC-310** x 25 Inside #1 Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap Row Length Adjustment= +0.44' x 2.07 sf x 5 rows
		869 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	156.50'	**2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 0.00'
#2	Primary	158.80'	**4.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Discarded OutFlow Max=0.0 cfs @ 12.07 hrs HW=159.31' (Free Discharge)
1=Exfiltration (Controls 0.0 cfs)

Primary OutFlow Max=4.4 cfs @ 12.07 hrs HW=159.31' TW=155.91' (Dynamic Tailwater)
2=Broad-Crested Rectangular Weir (Weir Controls 4.4 cfs @ 2.15 fps)

Pond 3P: Subsurface Infiltration #2 - Chamber Wizard Field A

Chamber Model = ADS_StormTechSC-310 (ADS StormTech® SC-310)
Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf
Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap
Row Length Adjustment= +0.44' x 2.07 sf x 5 rows

34.0" Wide + 6.0" Spacing = 40.0" C-C Row Spacing

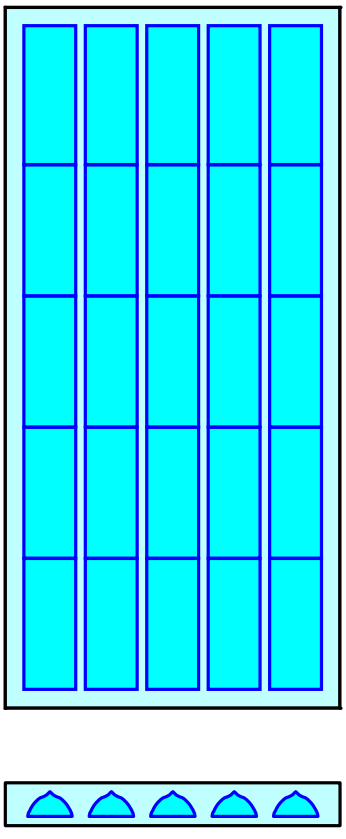
5 Chambers/Row x 7.12' Long +0.44' Row Adjustment = 36.04' Row Length +12.0" End Stone x 2 = 38.04' Base Length
5 Rows x 34.0" Wide + 6.0" Spacing x 4 + 12.0" Side Stone x 2 = 18.17' Base Width
6.0" Base + 16.0" Chamber Height + 6.0" Cover = 2.33' Field Height

25 Chambers x 14.7 cf +0.44' Row Adjustment x 2.07 sf x 5 Rows = 373.1 cf Chamber Storage

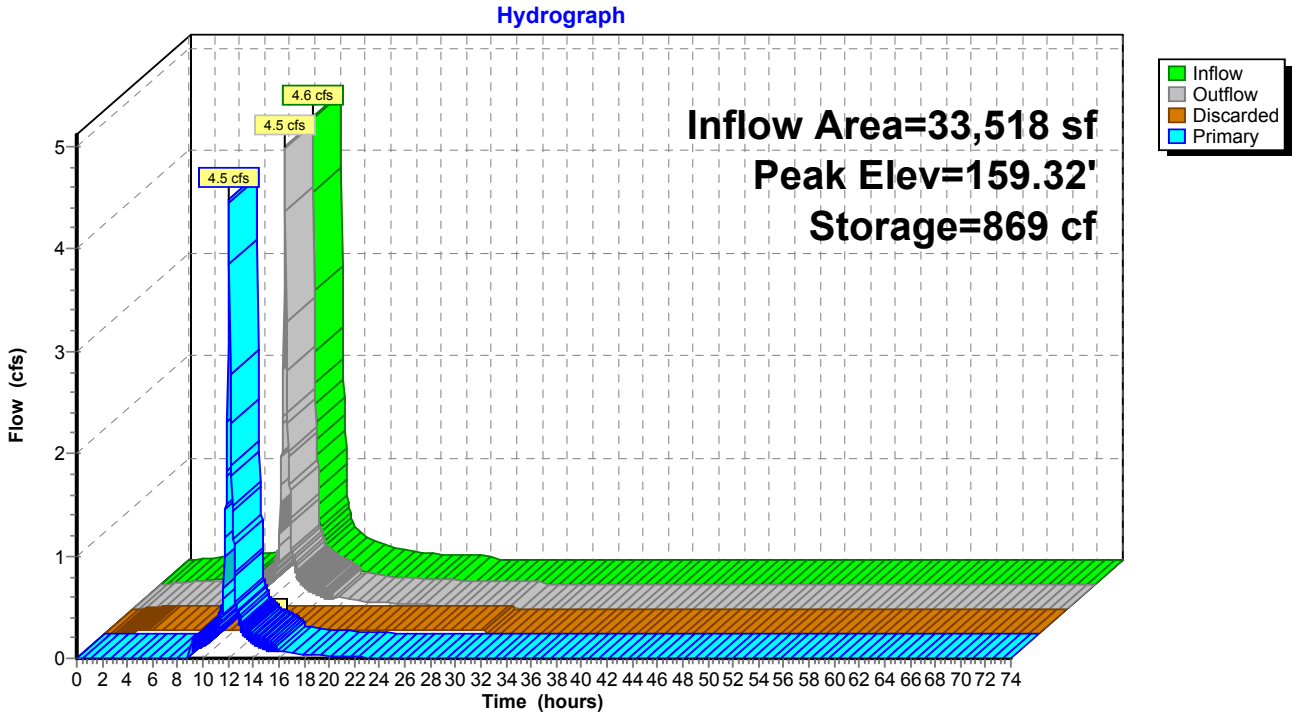
1,612.4 cf Field - 373.1 cf Chambers = 1,239.3 cf Stone x 40.0% Voids = 495.7 cf Stone Storage

Chamber Storage + Stone Storage = 868.8 cf = 0.0 af
Overall Storage Efficiency = 53.9%

25 Chambers
59.7 cy Field
45.9 cy Stone



Pond 3P: Subsurface Infiltration #2

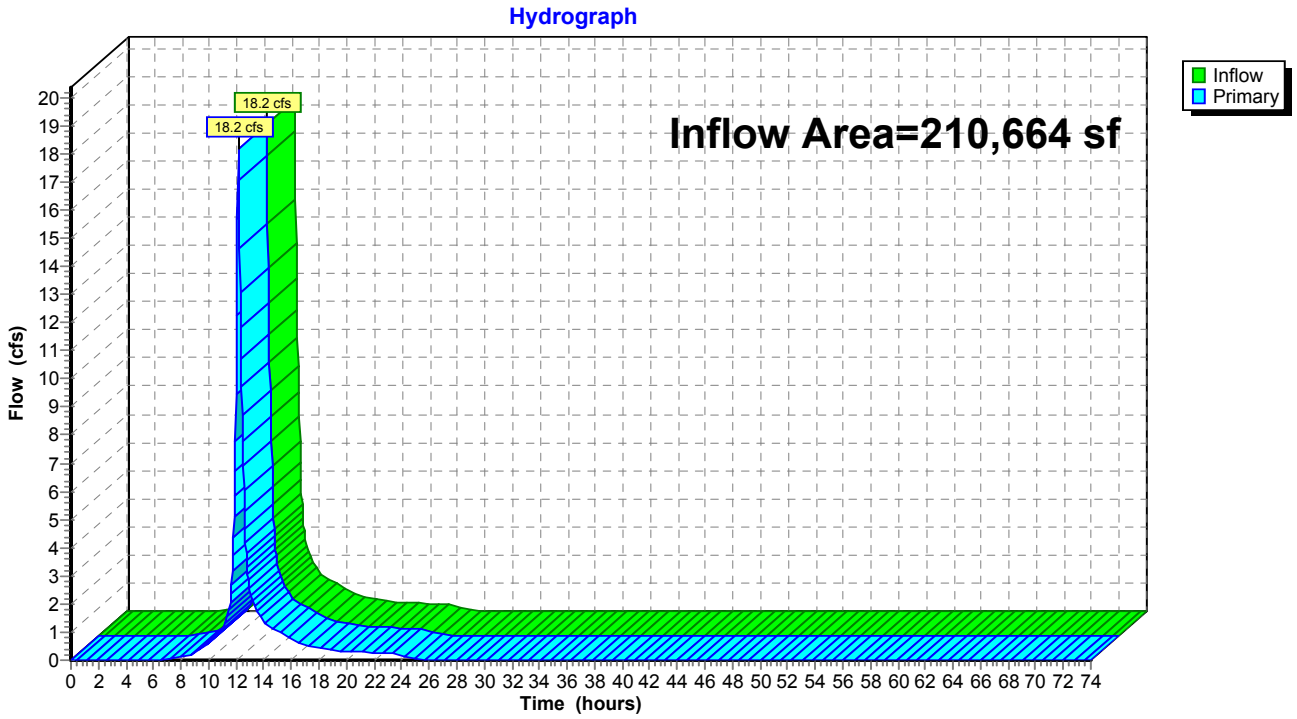


Summary for Link DP 1: South - Wetland

Inflow Area = 210,664 sf, 73.51% Impervious, Inflow Depth = 4.03" for 25-YR event
Inflow = 18.2 cfs @ 12.14 hrs, Volume= 70,800 cf
Primary = 18.2 cfs @ 12.14 hrs, Volume= 70,800 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs

Link DP 1: South - Wetland

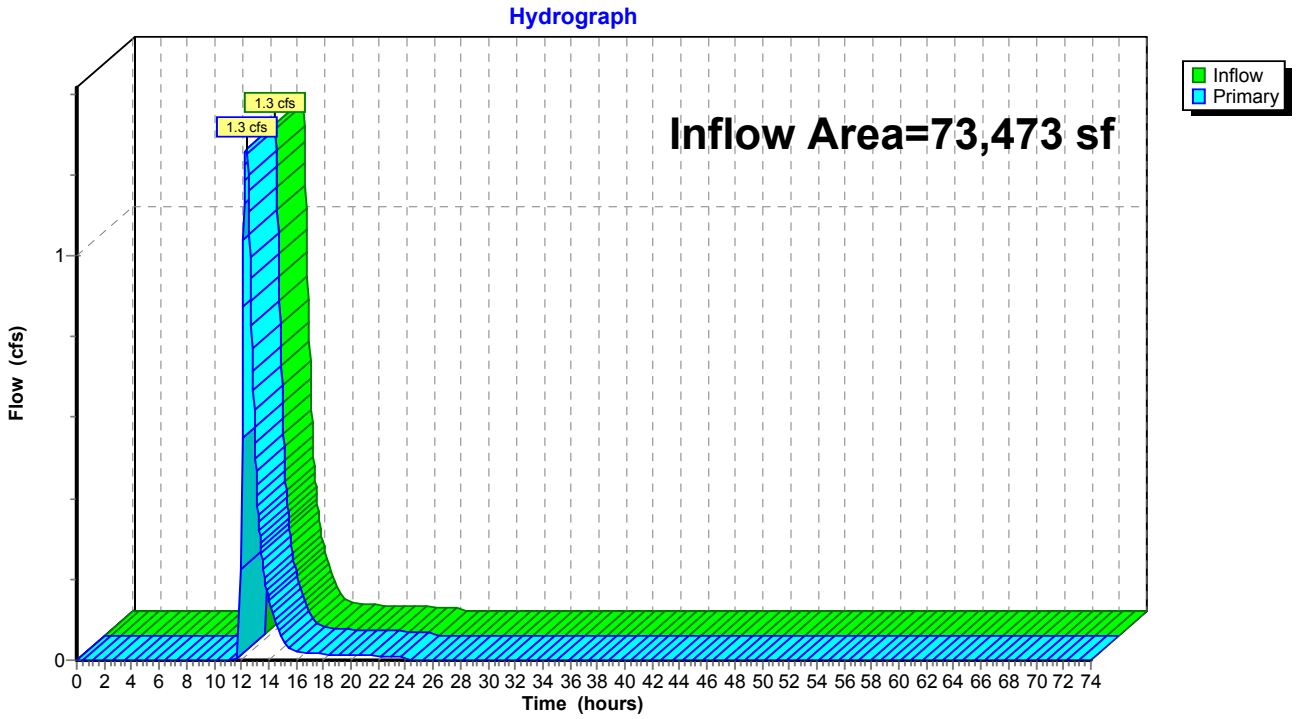


Summary for Link DP 2: North - Culvert

Inflow Area = 73,473 sf, 39.40% Impervious, Inflow Depth = 0.85" for 25-YR event
Inflow = 1.3 cfs @ 12.36 hrs, Volume= 5,190 cf
Primary = 1.3 cfs @ 12.36 hrs, Volume= 5,190 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs

Link DP 2: North - Culvert

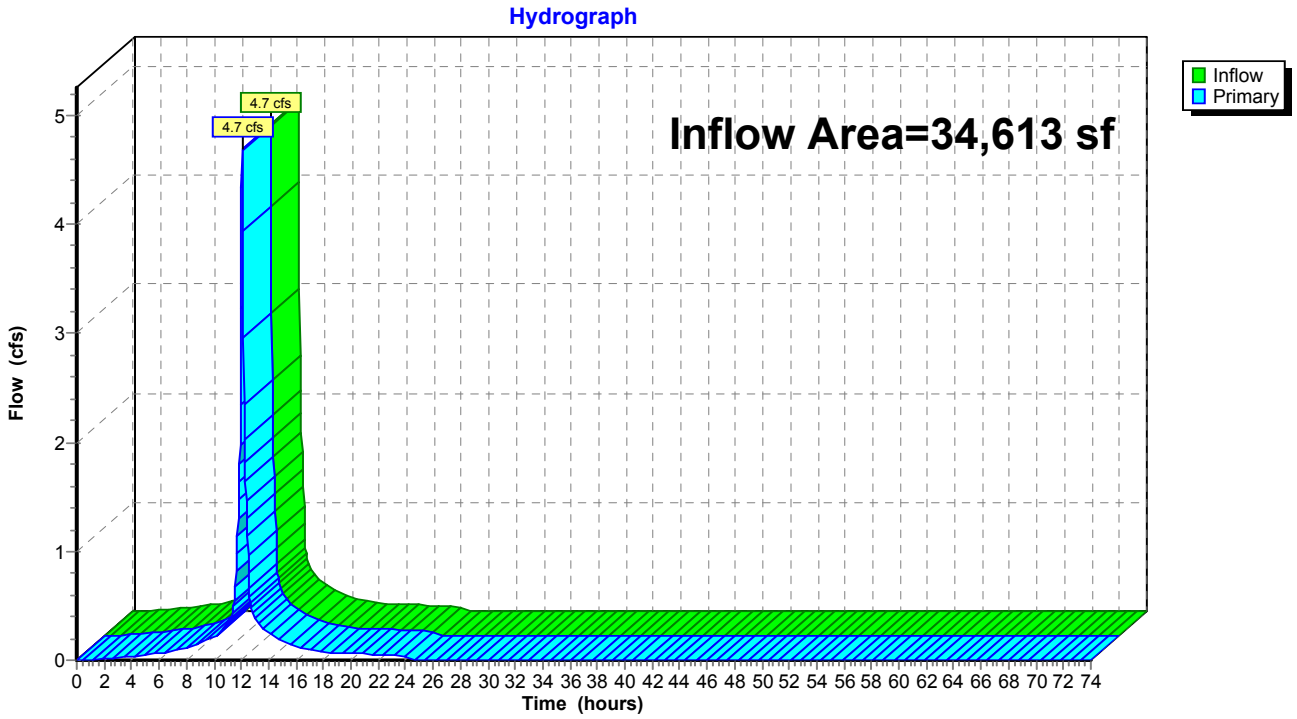


Summary for Link DP 3: Shoppers World Drive

Inflow Area = 34,613 sf, 98.21% Impervious, Inflow Depth = 5.58" for 25-YR event
Inflow = 4.7 cfs @ 12.07 hrs, Volume= 16,108 cf
Primary = 4.7 cfs @ 12.07 hrs, Volume= 16,108 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs

Link DP 3: Shoppers World Drive



100- Year-Storm-Event-Proposed

Summary for Subcatchment 10: Subcatchment 10

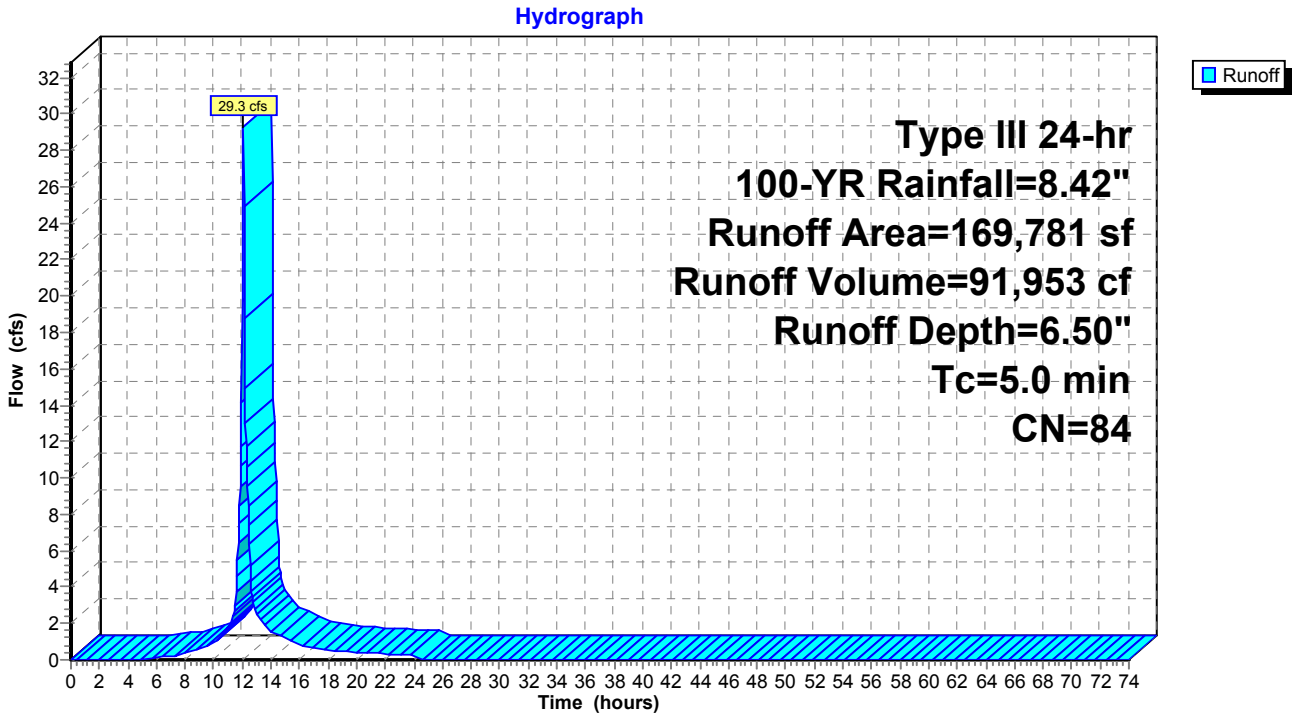
Runoff = 29.3 cfs @ 12.07 hrs, Volume= 91,953 cf, Depth= 6.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Type III 24-hr 100-YR Rainfall=8.42"

Area (sf)	CN	Description
121,346	98	Paved parking, HSG A
6,895	98	Water Surface, 0% imp, HSG A
140	98	Water Surface, 0% imp, HSG D
39,600	39	>75% Grass cover, Good, HSG A
1,800	80	>75% Grass cover, Good, HSG D
169,781	84	Weighted Average
48,435		28.53% Pervious Area
121,346		71.47% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 10: Subcatchment 10



Summary for Subcatchment 11A: Roof (Kings)

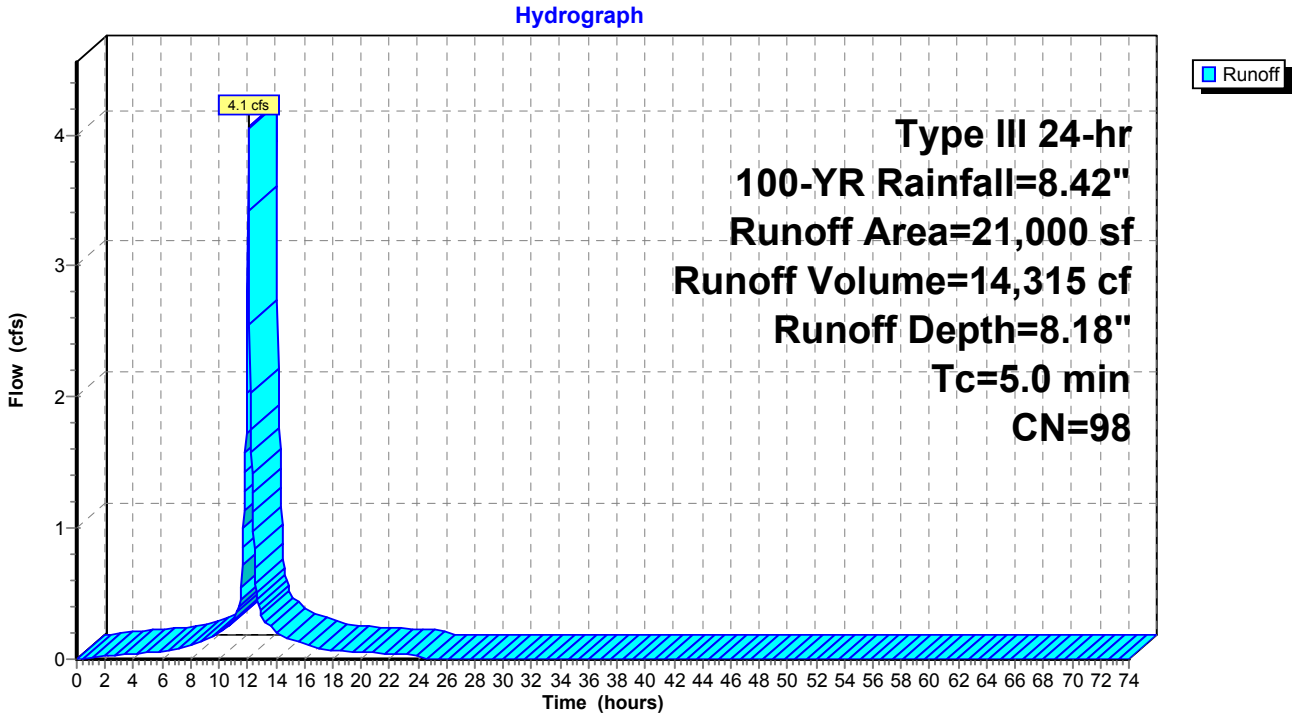
Runoff = 4.1 cfs @ 12.07 hrs, Volume= 14,315 cf, Depth= 8.18"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Type III 24-hr 100-YR Rainfall=8.42"

Area (sf)	CN	Description
21,000	98	Roofs, HSG A
21,000		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 11A: Roof (Kings)



Summary for Subcatchment 11B: Roof (Restaurant)

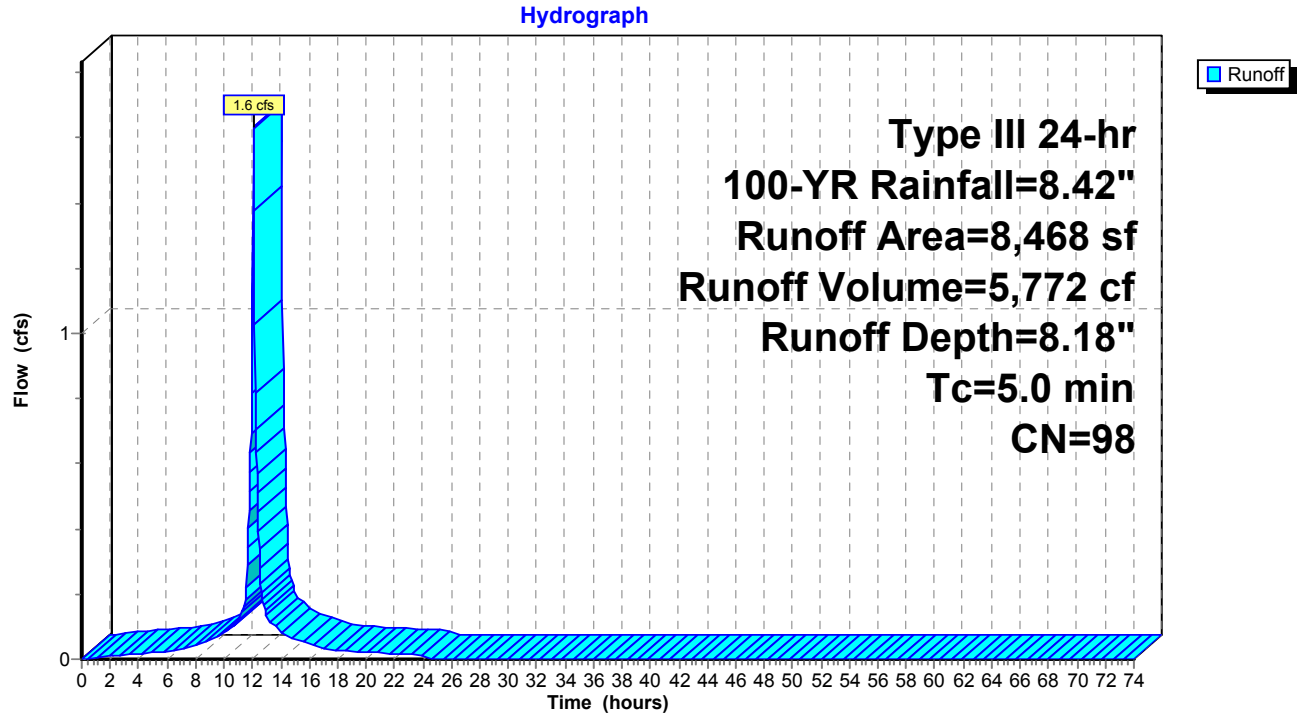
Runoff = 1.6 cfs @ 12.07 hrs, Volume= 5,772 cf, Depth= 8.18"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Type III 24-hr 100-YR Rainfall=8.42"

Area (sf)	CN	Description
8,468	98	Roofs, HSG A
8,468		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 11B: Roof (Restaurant)



Summary for Subcatchment 11C: Roof (Ifly,)

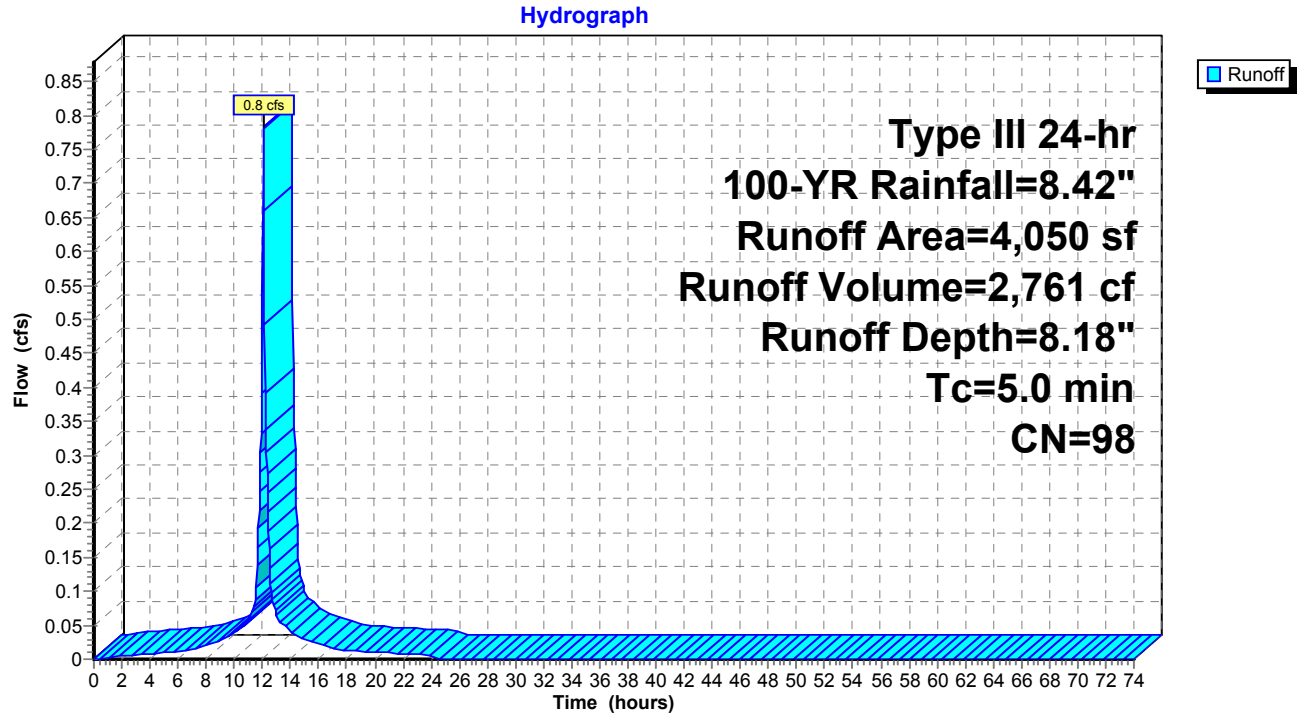
Runoff = 0.8 cfs @ 12.07 hrs, Volume= 2,761 cf, Depth= 8.18"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Type III 24-hr 100-YR Rainfall=8.42"

Area (sf)	CN	Description
4,050	98	Roofs, HSG A
4,050		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 11C: Roof (Ifly,)



Summary for Subcatchment 20: Subcatchment 20

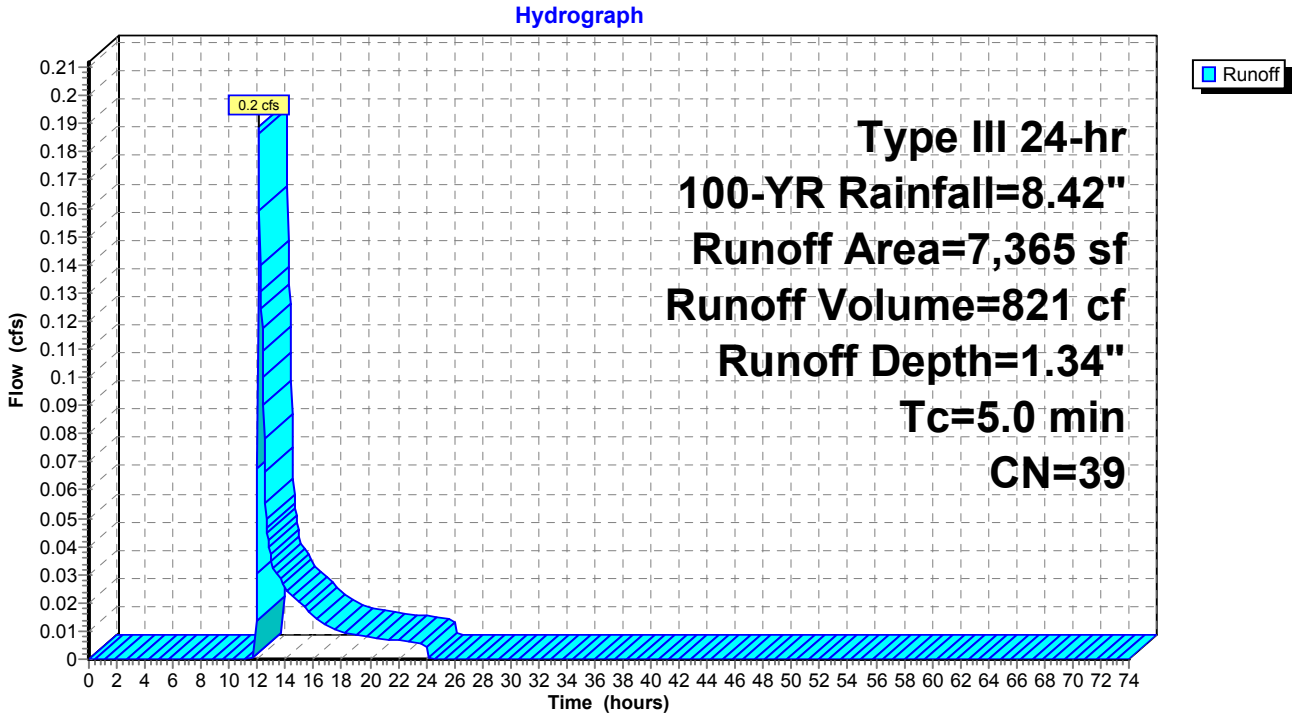
Runoff = 0.2 cfs @ 12.10 hrs, Volume= 821 cf, Depth= 1.34"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Type III 24-hr 100-YR Rainfall=8.42"

Area (sf)	CN	Description
7,365	39	>75% Grass cover, Good, HSG A
7,365		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 20: Subcatchment 20



Summary for Subcatchment 30: Subcatchment 30

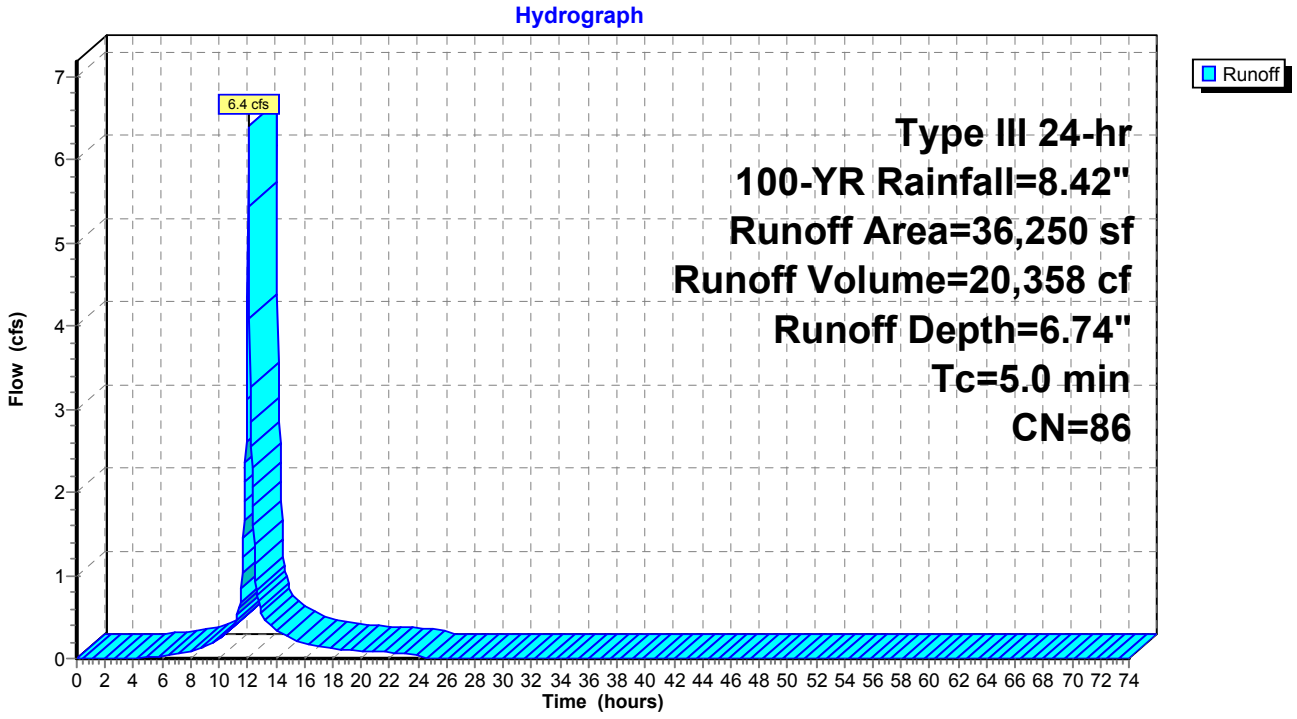
Runoff = 6.4 cfs @ 12.07 hrs, Volume= 20,358 cf, Depth= 6.74"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Type III 24-hr 100-YR Rainfall=8.42"

Area (sf)	CN	Description
28,950	98	Paved parking, HSG A
7,300	39	>75% Grass cover, Good, HSG A
36,250	86	Weighted Average
7,300		20.14% Pervious Area
28,950		79.86% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 30: Subcatchment 30



Summary for Subcatchment 40: Subcatchment 40

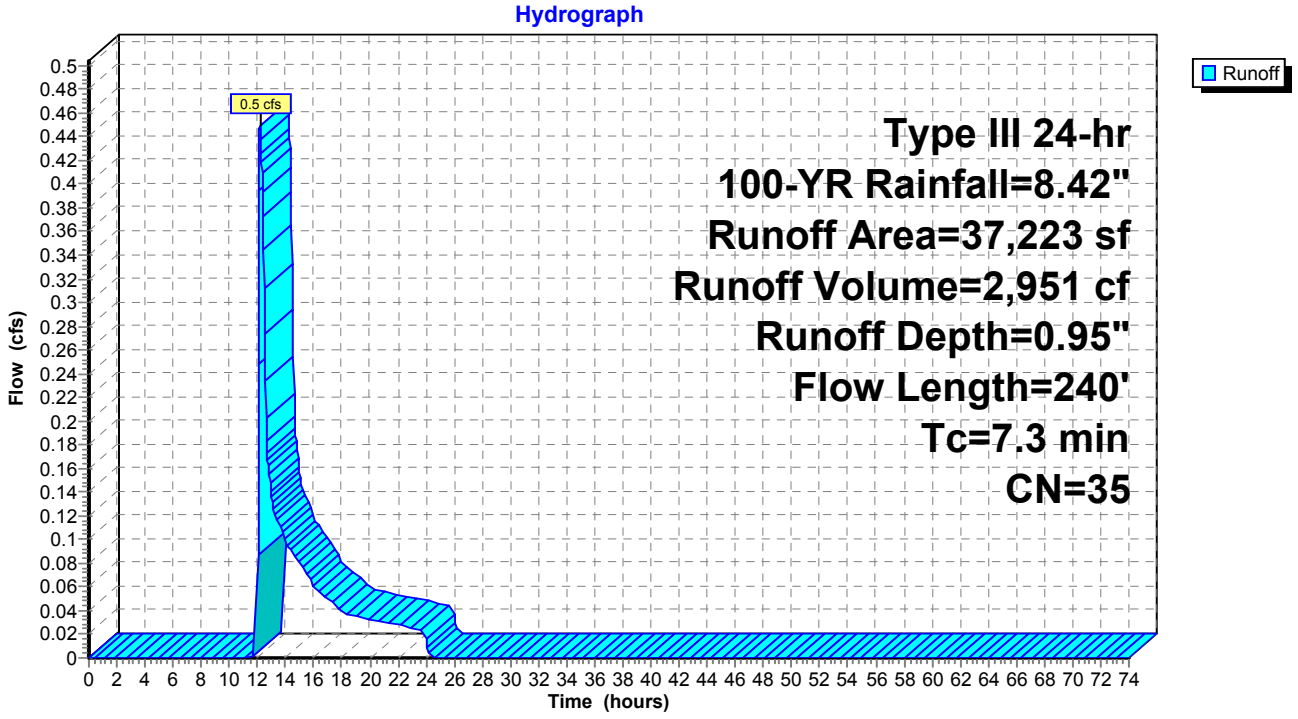
Runoff = 0.5 cfs @ 12.17 hrs, Volume= 2,951 cf, Depth= 0.95"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Type III 24-hr 100-YR Rainfall=8.42"

Area (sf)	CN	Description
18,876	39	>75% Grass cover, Good, HSG A
18,347	30	Woods, Good, HSG A
37,223	35	Weighted Average
37,223		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	20	0.3000	0.35		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.00"
3.3	30	0.0300	0.15		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.00"
2.4	114	0.0130	0.80		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.7	76	0.0130	1.71		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
7.3	240	Total			

Subcatchment 40: Subcatchment 40



Summary for Subcatchment 50: Subcatchment 50

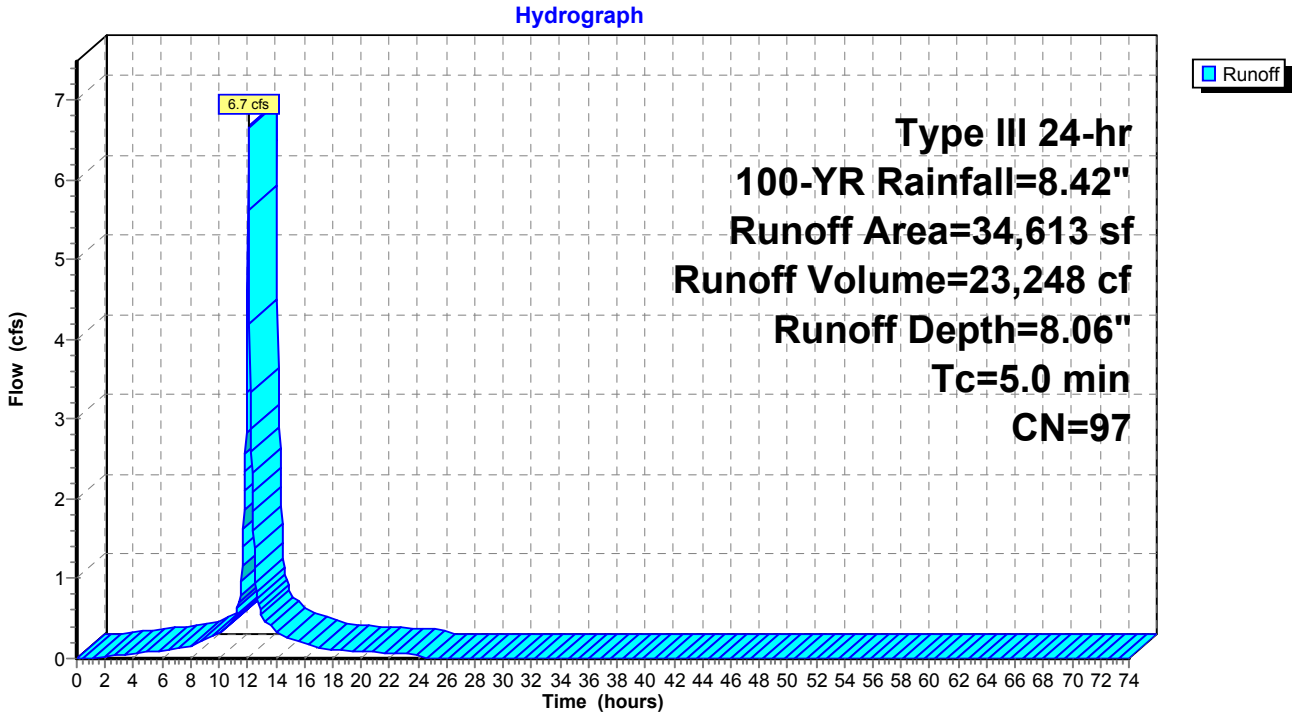
Runoff = 6.7 cfs @ 12.07 hrs, Volume= 23,248 cf, Depth= 8.06"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Type III 24-hr 100-YR Rainfall=8.42"

Area (sf)	CN	Description
33,995	98	Paved parking, HSG A
618	39	>75% Grass cover, Good, HSG A
34,613	97	Weighted Average
618		1.79% Pervious Area
33,995		98.21% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 50: Subcatchment 50



Summary for Pond 1P: Existing Pond - South

Inflow Area = 203,299 sf, 76.18% Impervious, Inflow Depth = 6.53" for 100-YR event
Inflow = 35.7 cfs @ 12.07 hrs, Volume= 110,708 cf
Outflow = 29.1 cfs @ 12.13 hrs, Volume= 110,708 cf, Atten= 18%, Lag= 3.3 min
Primary = 1.5 cfs @ 12.13 hrs, Volume= 800 cf
Secondary = 27.7 cfs @ 12.13 hrs, Volume= 109,909 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Starting Elev= 155.00' Surf.Area= 7,687 sf Storage= 16,436 cf
Peak Elev= 156.38' @ 12.13 hrs Surf.Area= 9,029 sf Storage= 27,927 cf (11,492 cf above start)

Plug-Flow detention time= 109.4 min calculated for 94,222 cf (85% of inflow)
Center-of-Mass det. time= 13.7 min (798.2 - 784.5)

Volume	Invert	Avail.Storage	Storage Description
#1	152.00'	49,544 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

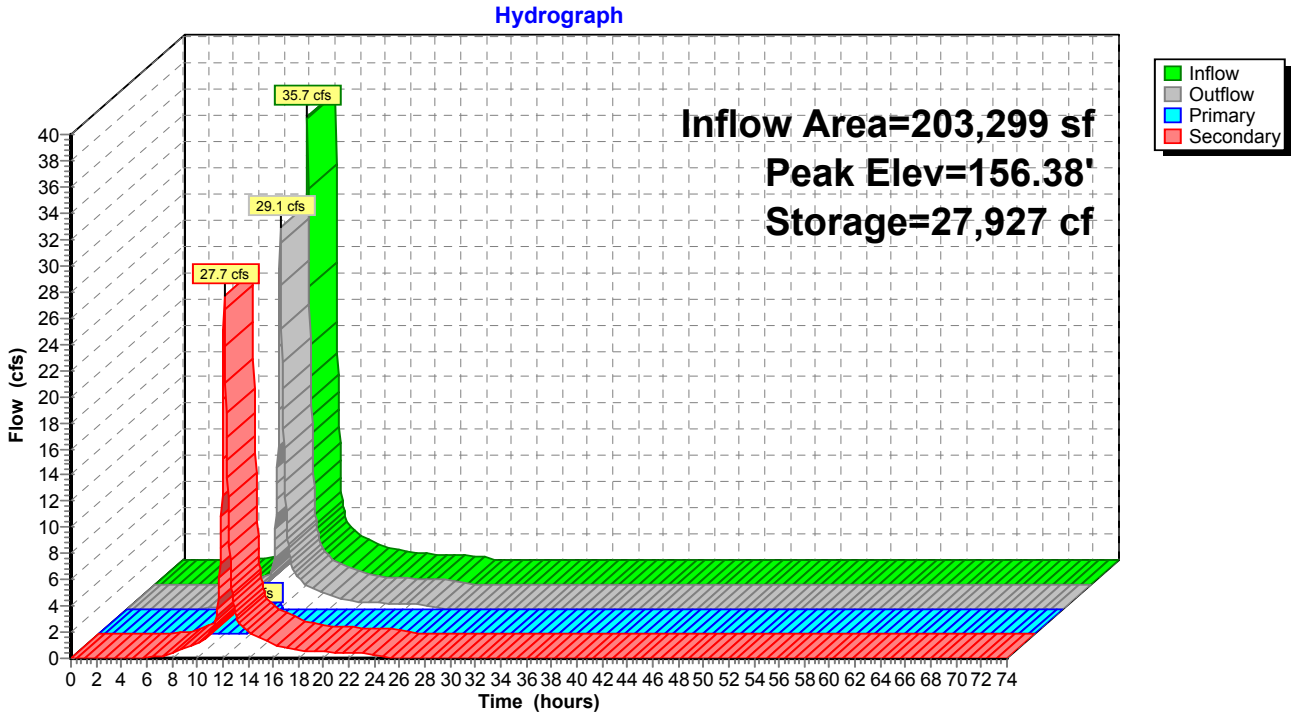
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
152.00	3,444	0	0
153.00	4,709	4,077	4,077
154.00	6,161	5,435	9,512
155.00	7,687	6,924	16,436
156.00	8,650	8,169	24,604
157.00	9,657	9,154	33,758
158.00	10,747	10,202	43,960
158.50	11,591	5,585	49,544

Device	Routing	Invert	Outlet Devices
#1	Primary	155.90'	**30.0" Round Culvert** L= 7.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 155.90' / 153.90' S= 0.2857 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 4.91 sf
#2	Device 1	154.10'	**4.0" Vert. Orifice** C= 0.600
#3	Device 1	155.30'	**45.0 deg Sharp-Crested Vee/Trap Weir** Cv= 2.56 (C= 3.20)
#4	Device 1	158.31'	**48.0" x 48.0" Horiz. Grate** C= 0.600 Limited to weir flow at low heads
#5	Secondary	155.00'	**6.5' long x 20.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=1.4 cfs @ 12.13 hrs HW=156.36' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Passes 1.4 cfs of 1.5 cfs potential flow)
  ├─**2=Orifice** (Orifice Controls 0.3 cfs @ 3.28 fps)
  ├─**3=Sharp-Crested Vee/Trap Weir** (Weir Controls 1.1 cfs @ 2.38 fps)
  └─**4=Grate** (Controls 0.0 cfs)

Secondary OutFlow Max=27.4 cfs @ 12.13 hrs HW=156.37' TW=0.00' (Dynamic Tailwater)
└─**5=Broad-Crested Rectangular Weir** (Weir Controls 27.4 cfs @ 3.08 fps)

Pond 1P: Existing Pond - South



Summary for Pond 2P: Subsurface Basin

[93] Warning: Storage range exceeded by 0.15'
[87] Warning: Oscillations may require smaller dt or Finer Routing (severity=42)

Inflow Area =	36,250 sf,	79.86% Impervious,	Inflow Depth =	6.74" for 100-YR event
Inflow =	6.4 cfs @	12.07 hrs, Volume=	20,358 cf	
Outflow =	4.4 cfs @	12.16 hrs, Volume=	20,361 cf,	Atten= 31%, Lag= 5.3 min
Discarded =	0.2 cfs @	12.16 hrs, Volume=	10,845 cf	
Primary =	4.2 cfs @	12.16 hrs, Volume=	9,516 cf	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Peak Elev= 162.48' @ 12.16 hrs Surf.Area= 3,898 sf Storage= 5,006 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 47.7 min (832.9 - 785.2)

Volume	Invert	Avail.Storage	Storage Description
#1A	160.00'	2,726 cf	**38.17'W x 102.12'L x 2.33'H Field A** 9,094 cf Overall - 2,280 cf Embedded = 6,814 cf x 40.0% Voids
#2A	160.50'	2,280 cf	**ADS_StormTech SC-310** x 154 Inside #1 Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap Row Length Adjustment= +0.44' x 2.07 sf x 11 rows
		5,006 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	160.00'	**2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 0.00'
#2	Primary	162.30'	**3.7' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#3	Primary	160.70'	**8.0" Vert. Orifice/Grate** C= 0.600
#4	Primary	161.50'	**8.0" Vert. Orifice/Grate** C= 0.600

Discarded OutFlow Max=0.2 cfs @ 12.16 hrs HW=162.47' (Free Discharge)
└**1=Exfiltration** (Controls 0.2 cfs)

Primary OutFlow Max=4.1 cfs @ 12.16 hrs HW=162.48' TW=0.00' (Dynamic Tailwater)
├**2=Broad-Crested Rectangular Weir** (Weir Controls 0.8 cfs @ 1.18 fps)
├**3=Orifice/Grate** (Orifice Controls 2.0 cfs @ 5.78 fps)
└**4=Orifice/Grate** (Orifice Controls 1.3 cfs @ 3.86 fps)

Pond 2P: Subsurface Basin - Chamber Wizard Field A

Chamber Model = ADS_StormTechSC-310 (ADS StormTech® SC-310)
Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf
Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap
Row Length Adjustment= +0.44' x 2.07 sf x 11 rows

34.0" Wide + 6.0" Spacing = 40.0" C-C Row Spacing

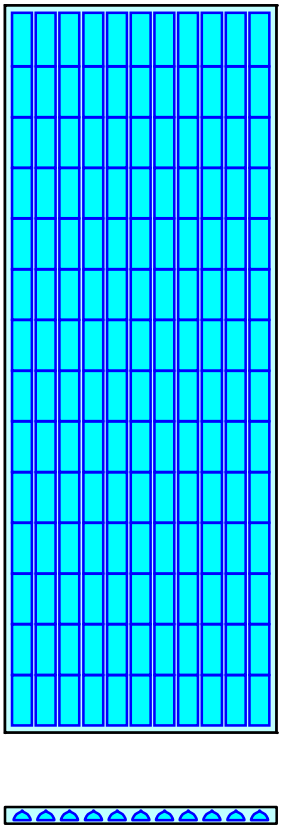
14 Chambers/Row x 7.12' Long +0.44' Row Adjustment = 100.12' Row Length +12.0" End Stone x 2 = 102.12' Base Length
11 Rows x 34.0" Wide + 6.0" Spacing x 10 + 12.0" Side Stone x 2 = 38.17' Base Width
6.0" Base + 16.0" Chamber Height + 6.0" Cover = 2.33' Field Height

154 Chambers x 14.7 cf +0.44' Row Adjustment x 2.07 sf x 11 Rows = 2,280.2 cf Chamber Storage

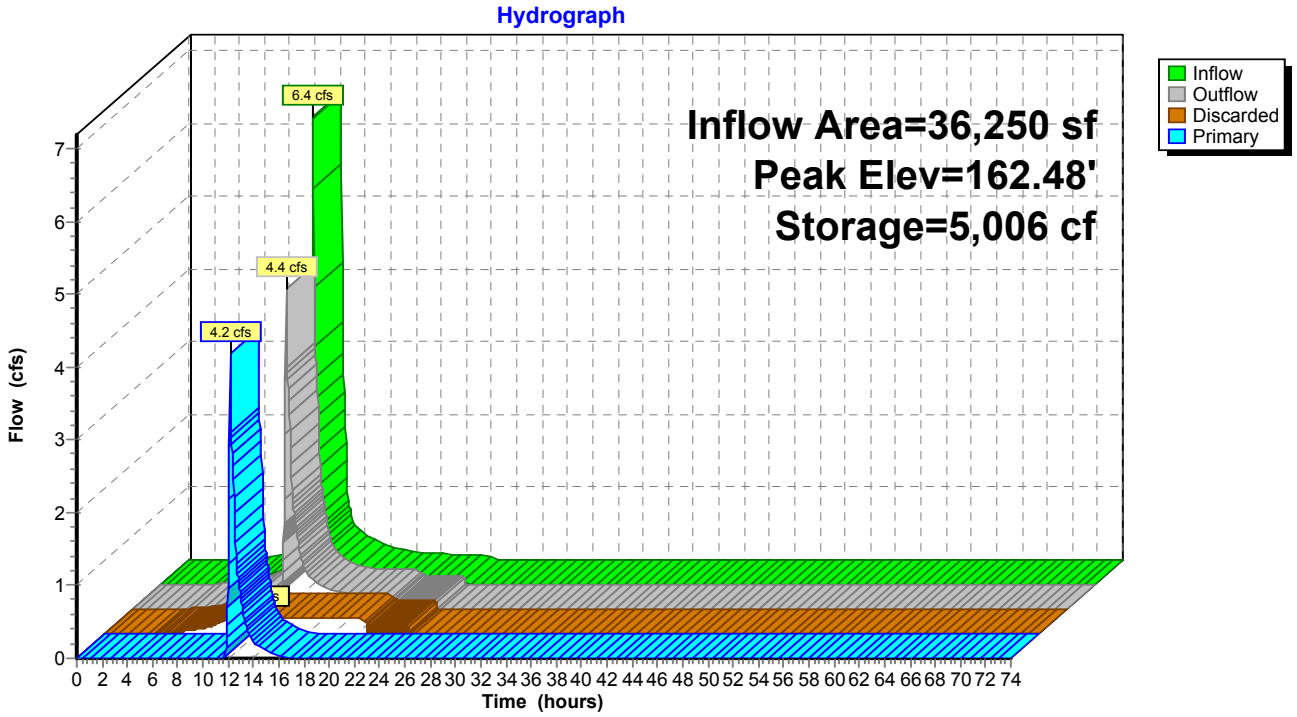
9,094.2 cf Field - 2,280.2 cf Chambers = 6,814.0 cf Stone x 40.0% Voids = 2,725.6 cf Stone Storage

Chamber Storage + Stone Storage = 5,005.8 cf = 0.1 af
Overall Storage Efficiency = 55.0%

154 Chambers
336.8 cy Field
252.4 cy Stone



Pond 2P: Subsurface Basin



Summary for Pond 3P: Subsurface Infiltration #2

[93] Warning: Storage range exceeded by 0.61'

Inflow Area = 33,518 sf,100.00% Impervious, Inflow Depth = 8.18" for 100-YR event
Inflow = 6.5 cfs @ 12.07 hrs, Volume= 22,848 cf
Outflow = 6.5 cfs @ 12.07 hrs, Volume= 22,848 cf, Atten= 0%, Lag= 0.0 min
Discarded = 0.0 cfs @ 12.07 hrs, Volume= 4,092 cf
Primary = 6.4 cfs @ 12.07 hrs, Volume= 18,756 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs
Peak Elev= 159.44' @ 12.07 hrs Surf.Area= 691 sf Storage= 869 cf

Plug-Flow detention time= 48.8 min calculated for 22,836 cf (100% of inflow)
Center-of-Mass det. time= 49.0 min (788.7 - 739.7)

Volume	Invert	Avail.Storage	Storage Description
#1A	156.50'	496 cf	**18.17'W x 38.04'L x 2.33'H Field A** 1,612 cf Overall - 373 cf Embedded = 1,239 cf x 40.0% Voids
#2A	157.00'	373 cf	**ADS_StormTech SC-310** x 25 Inside #1 Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap Row Length Adjustment= +0.44' x 2.07 sf x 5 rows
		869 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	156.50'	**2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 0.00'
#2	Primary	158.80'	**4.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Discarded OutFlow Max=0.0 cfs @ 12.07 hrs HW=159.44' (Free Discharge)
↑—**1=Exfiltration** (Controls 0.0 cfs)

Primary OutFlow Max=6.3 cfs @ 12.07 hrs HW=159.44' TW=156.25' (Dynamic Tailwater)
↑—**2=Broad-Crested Rectangular Weir** (Weir Controls 6.3 cfs @ 2.49 fps)

Pond 3P: Subsurface Infiltration #2 - Chamber Wizard Field A

Chamber Model = ADS_StormTechSC-310 (ADS StormTech® SC-310)
Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf
Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap
Row Length Adjustment= +0.44' x 2.07 sf x 5 rows

34.0" Wide + 6.0" Spacing = 40.0" C-C Row Spacing

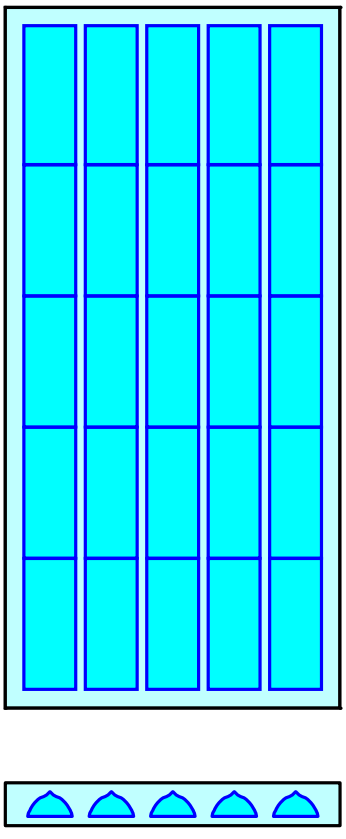
5 Chambers/Row x 7.12' Long +0.44' Row Adjustment = 36.04' Row Length +12.0" End Stone x 2 = 38.04' Base Length
5 Rows x 34.0" Wide + 6.0" Spacing x 4 + 12.0" Side Stone x 2 = 18.17' Base Width
6.0" Base + 16.0" Chamber Height + 6.0" Cover = 2.33' Field Height

25 Chambers x 14.7 cf +0.44' Row Adjustment x 2.07 sf x 5 Rows = 373.1 cf Chamber Storage

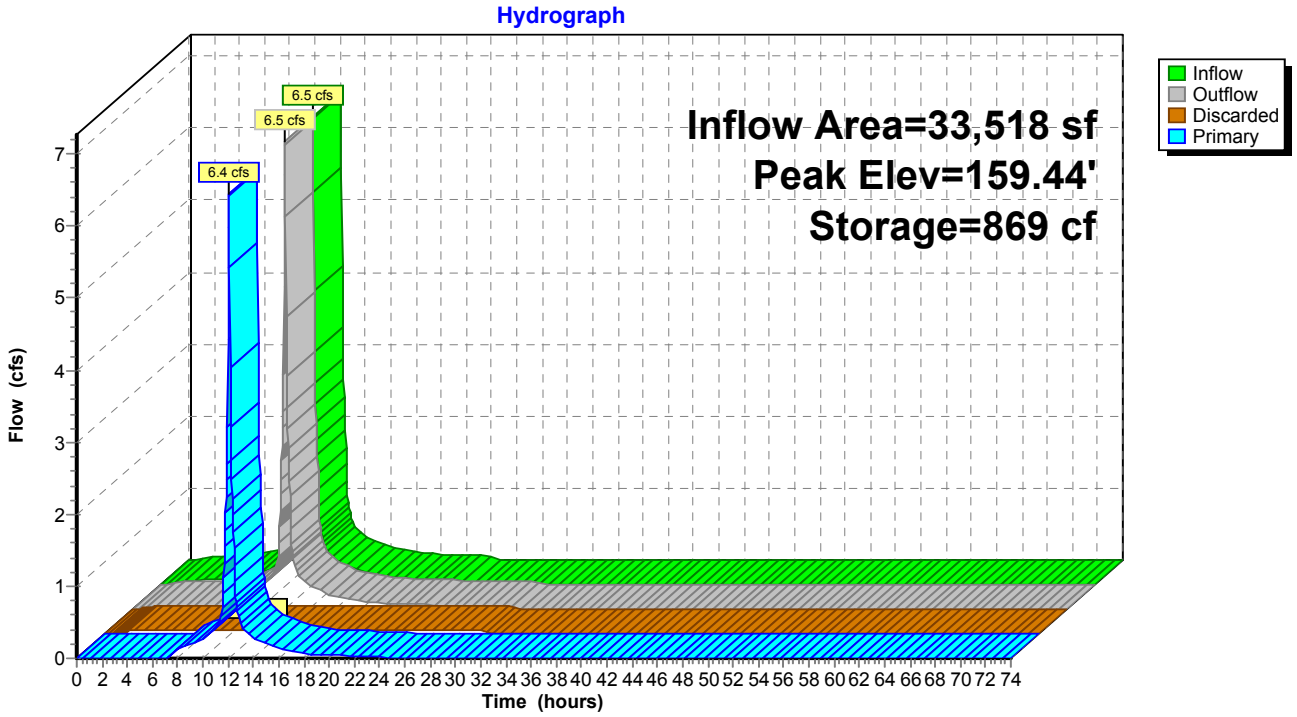
1,612.4 cf Field - 373.1 cf Chambers = 1,239.3 cf Stone x 40.0% Voids = 495.7 cf Stone Storage

Chamber Storage + Stone Storage = 868.8 cf = 0.0 af
Overall Storage Efficiency = 53.9%

25 Chambers
59.7 cy Field
45.9 cy Stone



Pond 3P: Subsurface Infiltration #2

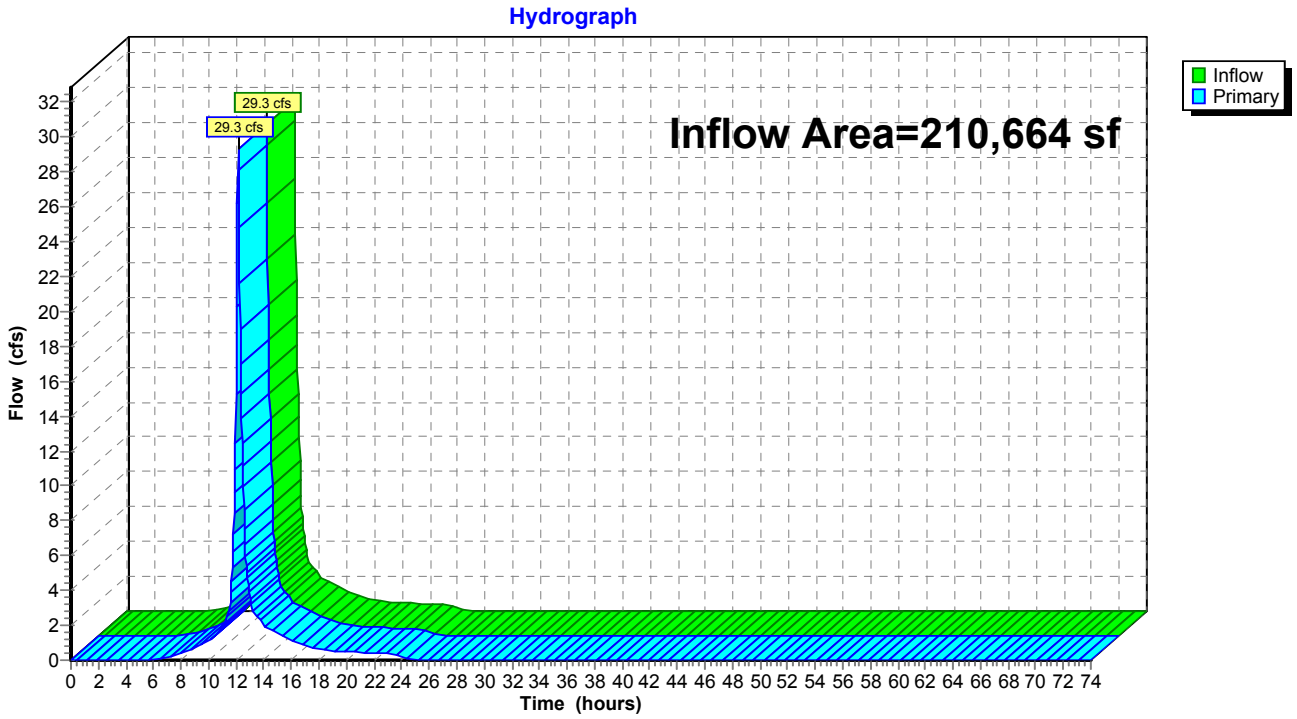


Summary for Link DP 1: South - Wetland

Inflow Area = 210,664 sf, 73.51% Impervious, Inflow Depth = 6.35" for 100-YR event
Inflow = 29.3 cfs @ 12.13 hrs, Volume= 111,529 cf
Primary = 29.3 cfs @ 12.13 hrs, Volume= 111,529 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs

Link DP 1: South - Wetland

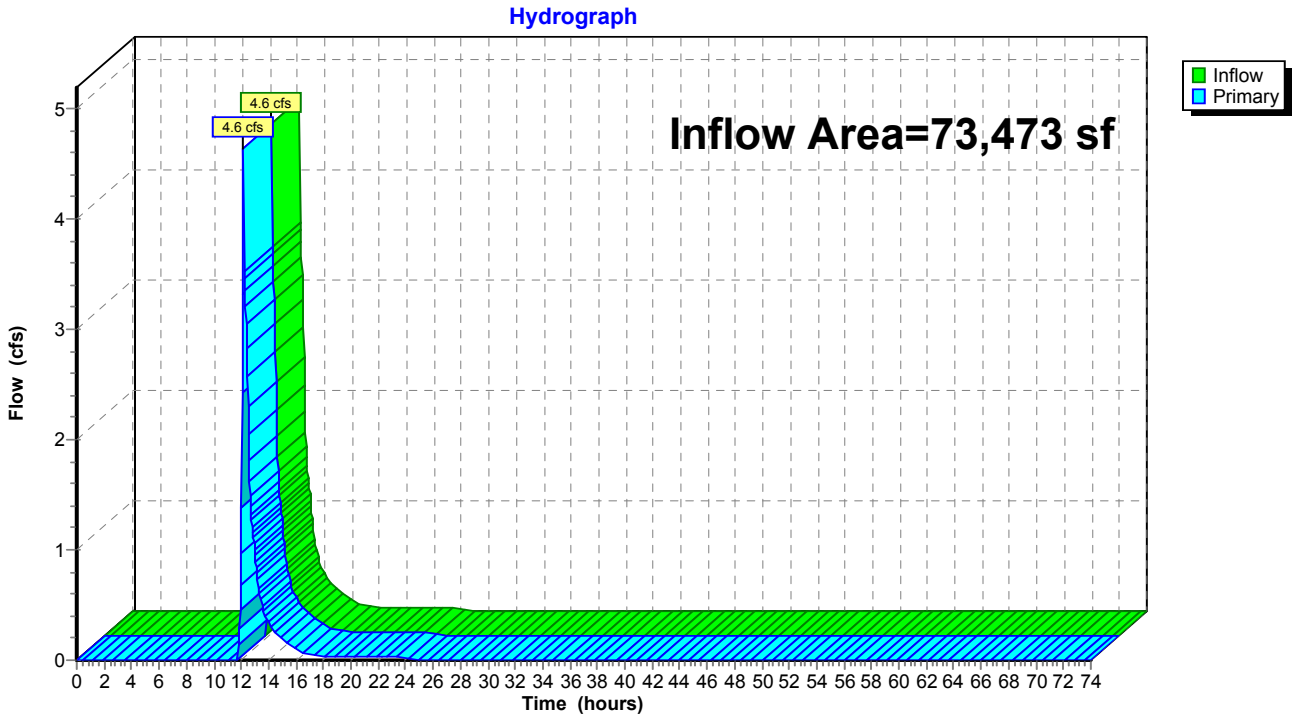


Summary for Link DP 2: North - Culvert

Inflow Area = 73,473 sf, 39.40% Impervious, Inflow Depth = 2.04" for 100-YR event
Inflow = 4.6 cfs @ 12.16 hrs, Volume= 12,467 cf
Primary = 4.6 cfs @ 12.16 hrs, Volume= 12,467 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs

Link DP 2: North - Culvert

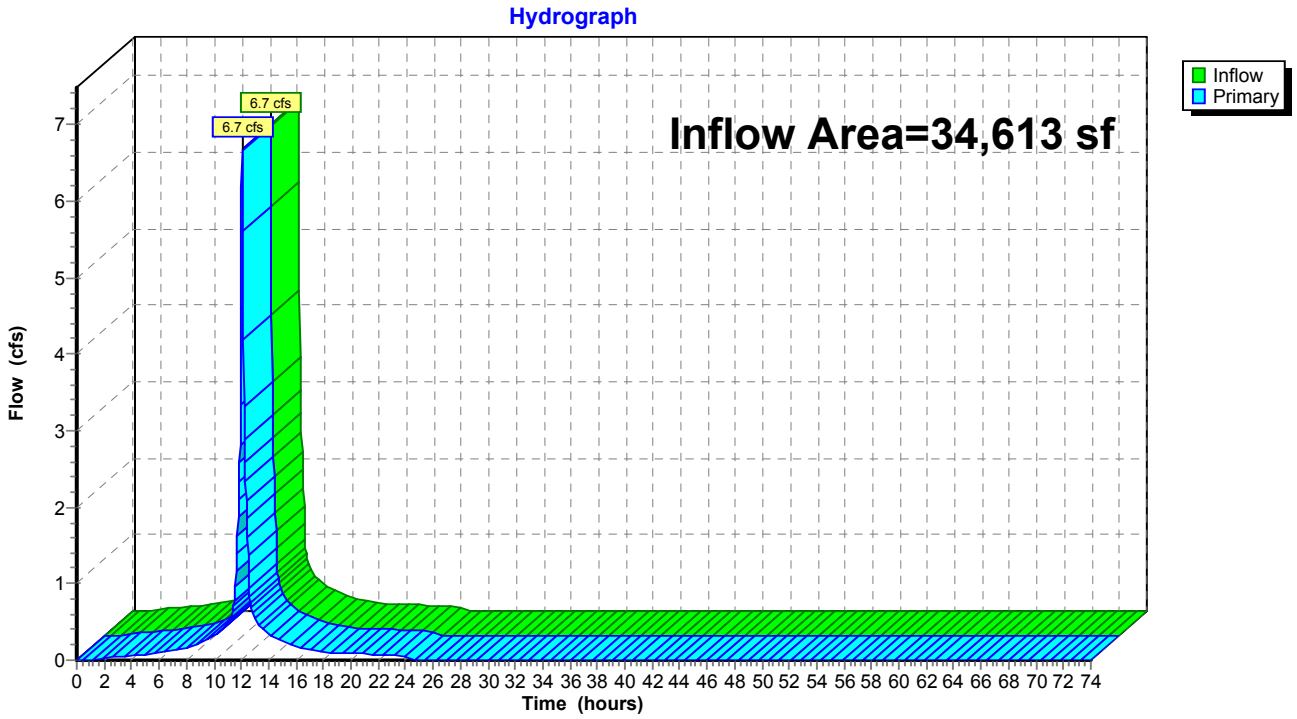


Summary for Link DP 3: Shoppers World Drive

Inflow Area = 34,613 sf, 98.21% Impervious, Inflow Depth = 8.06" for 100-YR event
Inflow = 6.7 cfs @ 12.07 hrs, Volume= 23,248 cf
Primary = 6.7 cfs @ 12.07 hrs, Volume= 23,248 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-74.00 hrs, dt= 0.04 hrs

Link DP 3: Shoppers World Drive



Appendix C
Standard 3 Computations and Supporting Information

Included in this section:

- NRCS Soil Information
- Required Recharge Volume Calculations
- FEMA Flood Map

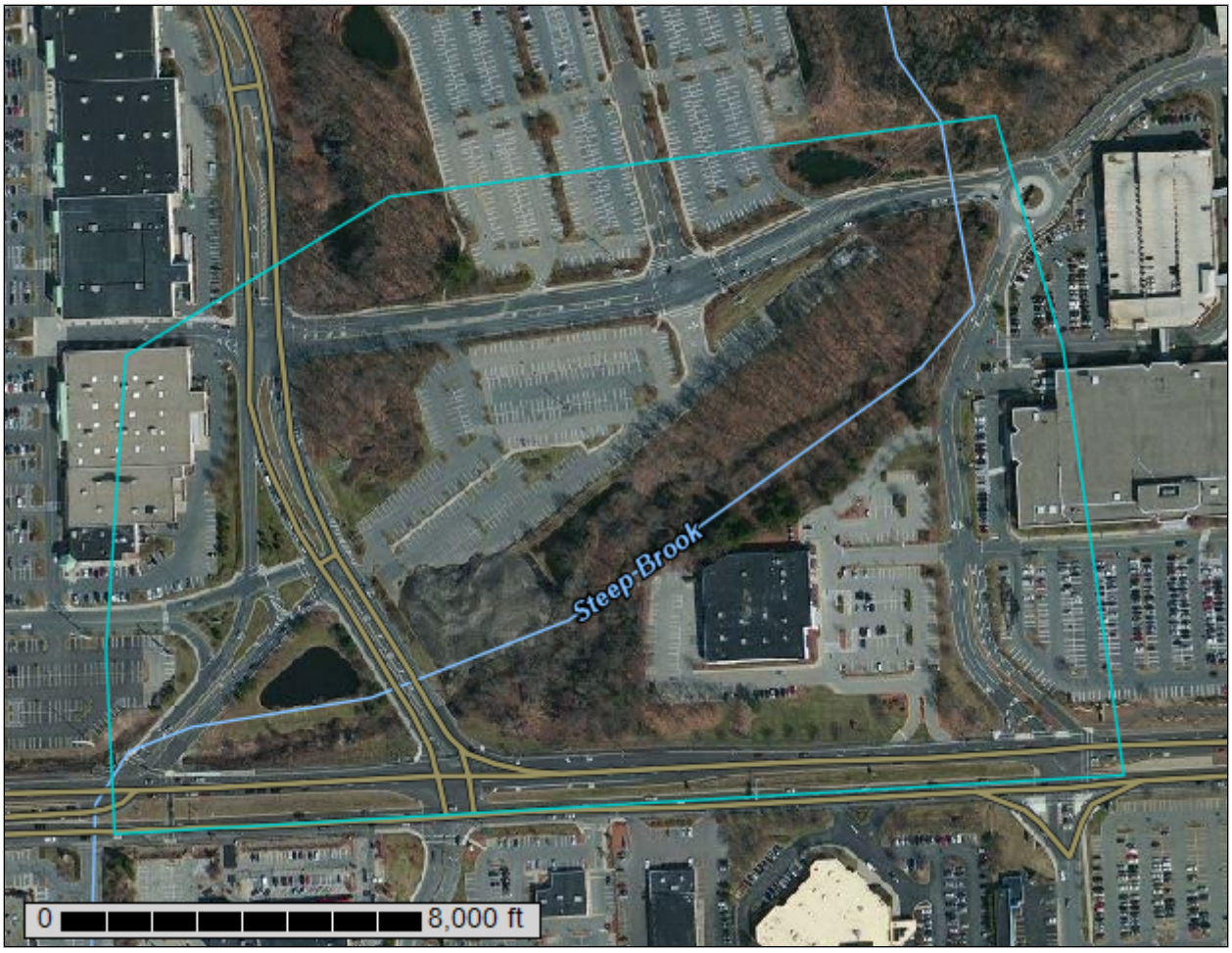
United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Middlesex County, Massachusetts



March 6, 2015

Custom Soil Resource Report
Soil Map

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:25,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Middlesex County, Massachusetts
Survey Area Data: Version 14, Sep 19, 2014

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 30, 2011—May 1, 2011

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

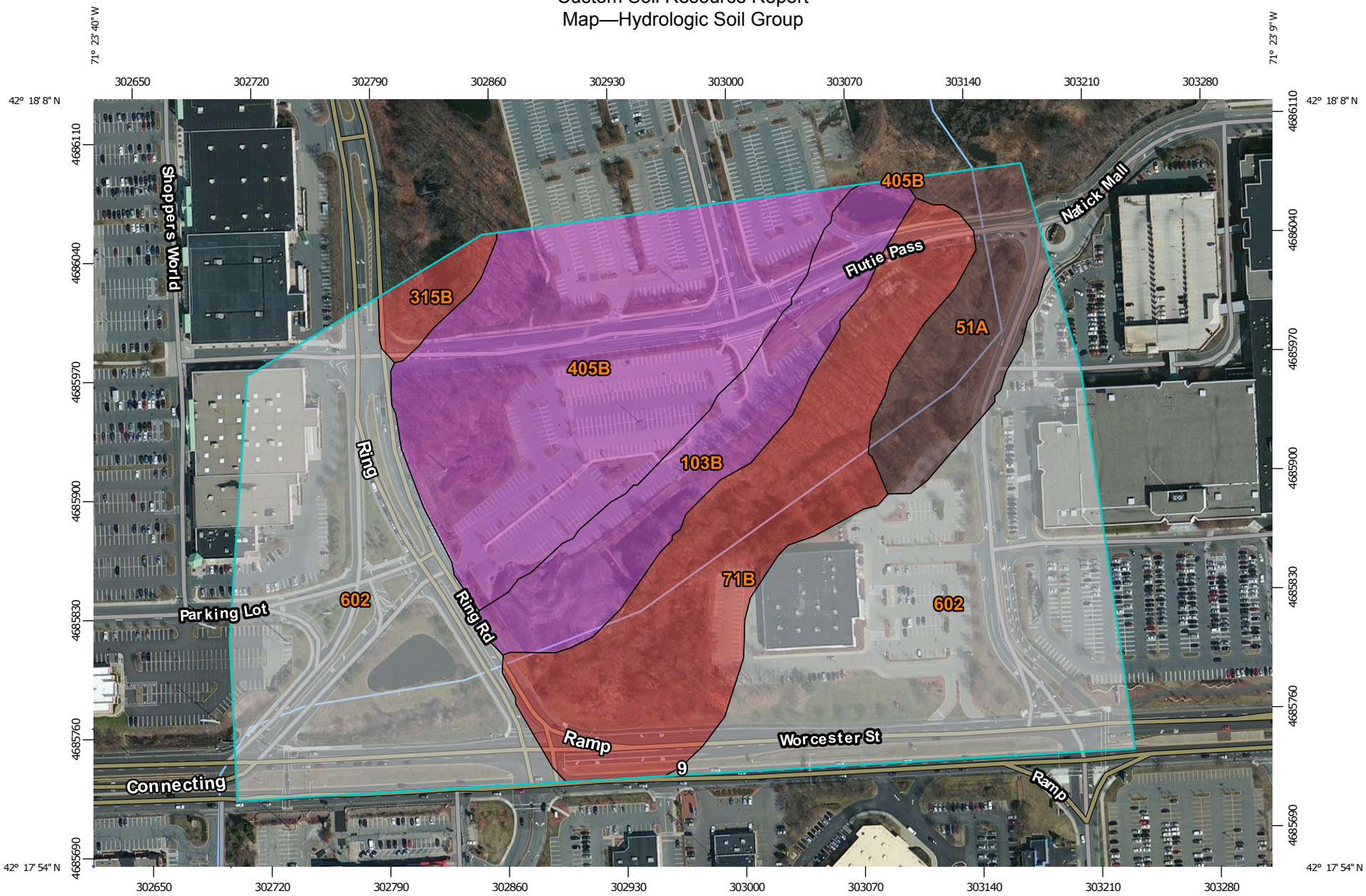
Middlesex County, Massachusetts (MA017)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
51A	Swansea muck, 0 to 1 percent slopes	2.6	6.4%
71B	Ridgebury fine sandy loam, 3 to 8 percent slopes, extremely stony	6.3	15.7%
103B	Charlton-Hollis-Rock outcrop complex, 3 to 8 percent slopes	3.5	8.7%
315B	Scituate fine sandy loam, 3 to 8 percent slopes	0.6	1.5%
405B	Charlton fine sandy loam, 3 to 8 percent slopes	8.7	21.7%
602	Urban land	18.5	46.1%
Totals for Area of Interest		**40.2**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially


71° 23' 40" W
71° 23' 9" W
42° 18' 8" N
42° 17' 54" N
302650
302720
302790
302860
302930
303000
303070
303140
303210
303280
4686110
4686040
4685970
4685900
4685830
4685760
4685690
405B
315B
405B
103B
71B
602
602
51A
Shoppers World
Natick Mall
Flutie Pass
Ring
Ring Rd
Parking Lot
Ramp
Worcester St
9
Connecting
Ramp
Map Scale: 1:3,180 if printed on A landscape (11" x 8.5") sheet.
N
Meters
0 45 90 180 270
Feet
0 150 300 600 900
Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 19N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

Soil Rating Polygons

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:25,000.

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Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Middlesex County, Massachusetts
Survey Area Data: Version 14, Sep 19, 2014

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 30, 2011—May 1, 2011

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Required Recharge Volume Calculations

Recharge Calculations

Project Name: Shoppers World | **Proj. No.:** 12642.0

Project Location: Framingham/ Natick, MA | **Date:** 7/15/2015

Calculated by: PLH

Checked by: NSS

Proposed Impervious Surface Summary - Design Point 2

Net Proposed Impervious Areas by Hydrologic Soil Group (HSG) in acres

Subcatchment	HSG A	HSG B	HSG C	HSG D	Total Area
30	0.2				0.2
TOTAL	**0.2**	**0.0**	**0.0**	**0.0**	**0.2**

Required Recharge Volume (Cubic Feet)

HSG	Area (acres)	Recharge Depth * (in.)	Volume (c.f.)
A	0.2	0.60	436
B	0.0	0.35	0
C	0.0	0.25	0
D	0.0	0.10	0
TOTAL			**436**

* Per 2008 Massachusetts DEP Recharge Requirement

Provided Recharge Volume (Cubic Feet)

Infiltration Volumes Provided in Infiltration Basins (below lowest overflow outlet)

2P	2582.00
Total	**2,582.00** c.f.

Basin Drawdown Time

Basin to drain within 72 hours

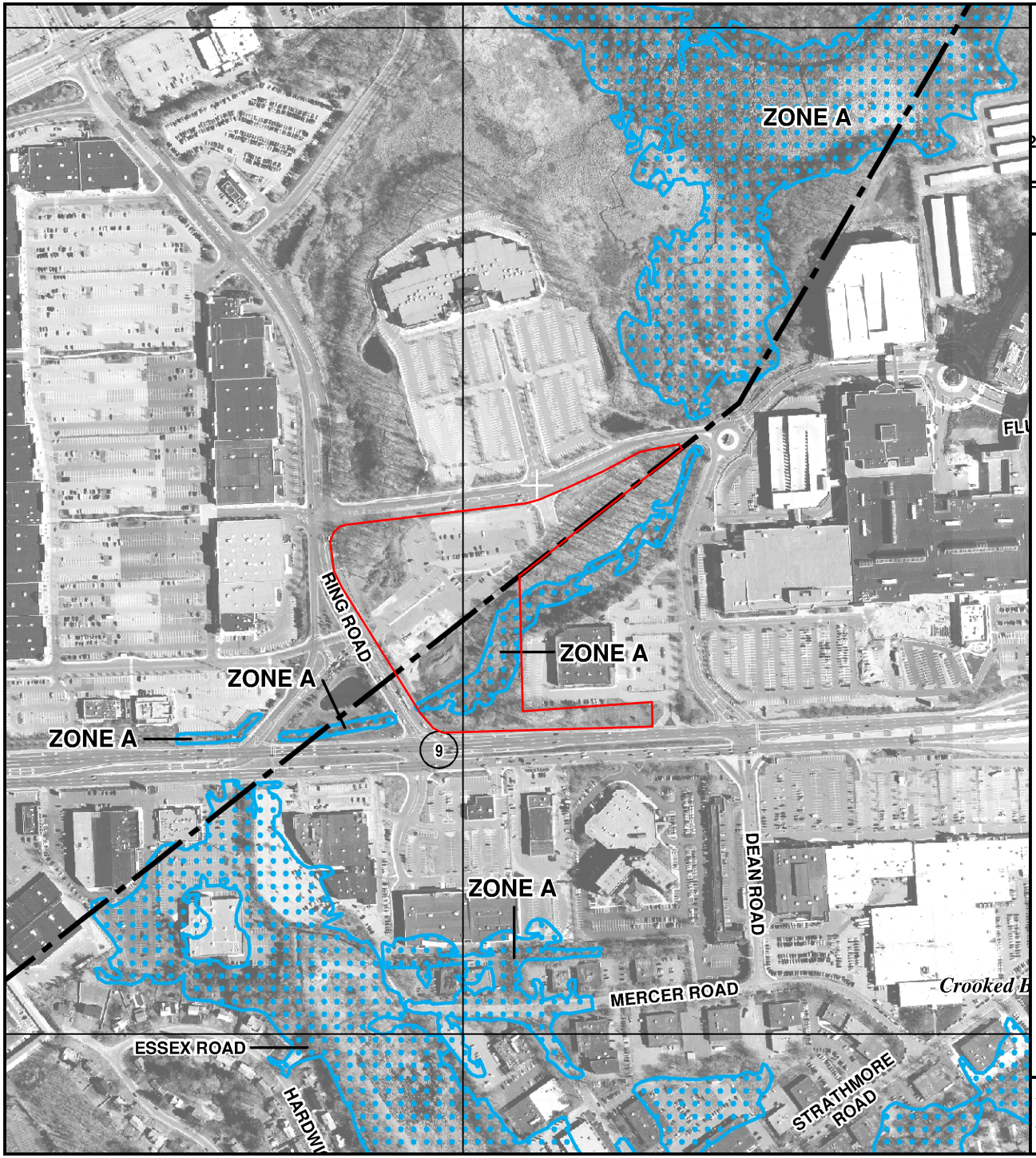
Storage Volume (cf)	2,582.00
Hydraulic Conductivity (K) (in/hr)	2.41
Bottom Area (sf)	1,817

Based on Rawls Rate for Sandy Loam

$$Time_{drawdown} = \frac{StorageVolume}{(K)(BottomArea)}$$

Drawdown Time (hours)	**7.08**

FEMA Flood Map



MAP SCALE 1" = 500'

250 0 500 1000

FEET

METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0517F

FIRM

FLOOD INSURANCE RATE MAP

MIDDLESEX COUNTY, MASSACHUSETTS

(ALL JURISDICTIONS)

PANEL 517 OF 656

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
FRAMINGHAM, TOWN OF	250193	0517	F
NATICK, TOWN OF	250207	0517	F
WAYLAND, TOWN OF	250224	0517	F

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
25017C0517F

MAP REVISED
JULY 7, 2014

Federal Emergency Management Agency

Appendix D
Standard 4 Computations and Supporting Information

Included in this section:

- TSS Removal Worksheets
- Water Quality Volume Calculations
- Water Quality Unit Sizing
- Long-Term Pollution Prevention Plan

TSS Removal Worksheets

TSS Removal Calculation Worksheet

Vanasse Hangen Brustlin, Inc.
Consulting Engineers and Planners
101 Walnut Street
Watertown, MA 02471
(617) 924-1770

Project Name:	**Shoppers World**	Sheet:	**1 of 1**
Project Number:	**12642.00**	Date:	**5-Aug-2015**
Location:	**Framingham/Natick, MA**	Computed by:	**PLH**
Discharge Point:	**DP 1**	Checked by:	**NSS**
Drainage Area(s):	**Subcatchments 10, 11, 20**		

A	B	C	D	E
BMP*	TSS Removal Rate*	Starting TSS Load**	Amount Removed (B*C)	Remaining Load (D-E)
Deep Sump and Hooded Catch Basin	**25%**	**1.00**	**0.25**	**0.75**
Stormceptor STC-900	**75%**	**0.75**	**0.56**	**0.19**
Wet Basin	**80%**	**0.19**	**0.15**	**0.04**
	0%	**0.04**	**0.00**	**0.04**
	0%	**0.04**	**0.00**	**0.04**

* BMP and TSS Removal Rate Values from the MassDEP Stormwater Handbook Vol. 1.
Removal rates for proprietary devices are from approved studies and/or manufacturer data
***To be conservative, 75% removal is used for this calculation based upon the NJCAT study provided on the MA STEP website.

Treatment Train TSS Removal = **96%**

TSS Removal Calculation Worksheet

Vanasse Hangen Brustlin, Inc.
Consulting Engineers and Planners
101 Walnut Street
Watertown, MA 02471
(617) 924-1770

Project Name:	**Shoppers World**	Sheet:	**1 of 1**
Project Number:	**12642.00**	Date:	**5-Aug-2015**
Location:	**Framingham/Natick, MA**	Computed by:	**PLH**
Discharge Point:	**DP 2**	Checked by:	**NSS**
Drainage Area(s):	**Subcatchments 30**		

A	B	C	D	E
BMP*	TSS Removal Rate*	Starting TSS Load**	Amount Removed (B*C)	Remaining Load (D-E)
Deep Sump and Hooded Catch Basin	**25%**	**1.00**	**0.25**	**0.75**
Isolator Row	**25%**	**0.75**	**0.19**	**0.56**
Subsurface Infiltration Structure	**80%**	**0.56**	**0.45**	**0.11**
	0%	**0.11**	**0.00**	**0.11**
	0%	**0.11**	**0.00**	**0.11**

* BMP and TSS Removal Rate Values from the MassDEP Stormwater Handbook Vol. 1.
Removal rates for proprietary devices are from manufacturer data
** Equals remaining load from previous BMP (E)

Treatment Train TSS Removal = **89%**

Water Quality Volume Calculations

VHB

Water Quality Volume Calculations

Project Name: Shoppers World

Project Location: Framingham / Natick, MA

Proj. No.: 12642.00

Date: 8/3/2015

REV. Date:

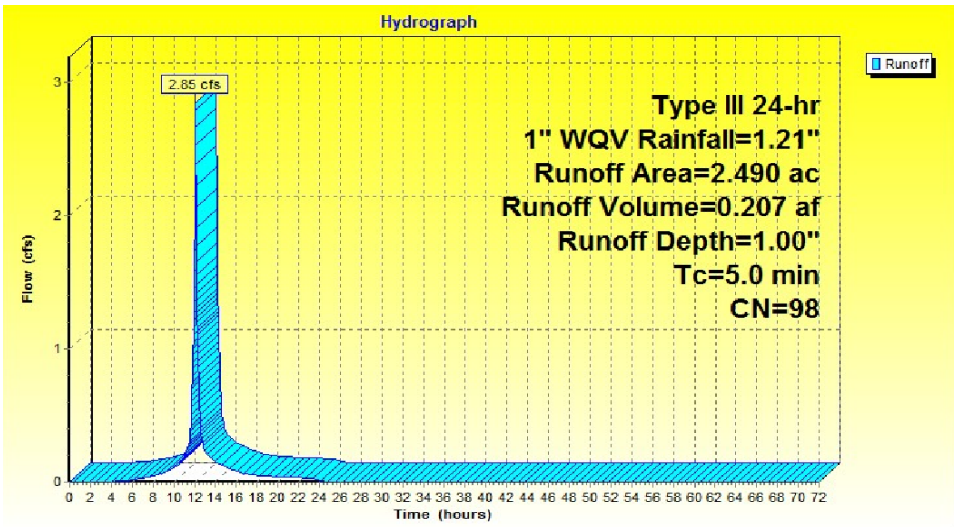
Calculated by: PLH

Design Point 1

Total Impervious Area = 2.49 Acres

Required:

	Runoff Depth to be Treated (in.)	Required Volume (c.f.)
Water Quality Volume	1	9,039



The above hydrograph shows a peak flow rate of 2.85 cfs must be treated for Area 1 to treat 0.207 acre feet.

Provided:

Subsurface Infiltration

Cumulative Storage @ Elev 154.1 = 10,143 cf

The existing wet basin provides 10,143 cf of water quality volume which exceeds required 9,039 cf

VHB

Water Quality Volume Calculations

Project Name: Shoppers World

Proj. No.: 12642.00

Project Location: Framingham / Natick, MA

Date: 8/3/2015

REV. Date:

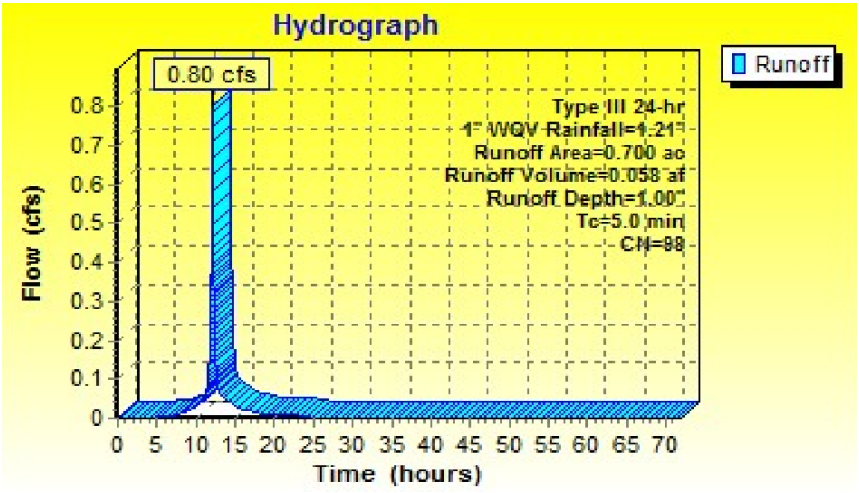
Calculated by: PLH

Design Point 2

Total Impervious Area = 0.70 Acres

Required:

	Runoff Depth to be Treated (in.)	Required Volume (c.f.)
Water Quality Volume	1	2,541



The above hydrograph shows a peak flow rate of 0.8 cfs must be treated for Area 1 to treat 0.058 acre feet.

Provided:

Subsurface Infiltration

Cumulative Storage @ Elev 161.92 = 2,582 cf

(See attached StormTech SC-740 Cumulative Storage Volume Calcs and Isolator Row Sizing Chart)

Project: **Shoppers World**

StormTech
Detention • Retention • Water Quality
A division of ADS

Chamber Model -	SC-740	
Units -	**Imperial**	Click Here for Metric
Number of chambers -	56	
Voids in the stone (porosity) -	40	%
Base of Stone Elevation -	160.00	ft
Amount of Stone Above Chambers -	6	in
Amount of Stone Below Chambers -	6	in

☐ Include Perimeter Stone in Calculations

Height of System *(inches)*	Incremental Single Chamber *(cubic feet)*	Incremental Total Chamber *(cubic feet)*	Incremental Stone *(cubic feet)*	Incremental Ch & St *(cubic feet)*	Cumulative Chamber *(cubic feet)*	Elevation *(feet)*
42	0.00	0.00	63.10	63.10	4194.19	163.50
41	0.00	0.00	63.10	63.10	4131.09	163.42
40	0.00	0.00	63.10	63.10	4067.99	163.33
39	0.00	0.00	63.10	63.10	4004.89	163.25
38	0.00	0.00	63.10	63.10	3941.79	163.17
37	0.00	0.00	63.10	63.10	3878.69	163.08
36	0.05	3.08	61.87	64.95	3815.59	163.00
35	0.16	9.12	59.45	68.58	3750.64	162.92
34	0.28	15.79	56.79	72.57	3682.06	162.83
33	0.60	33.82	49.57	83.39	3609.49	162.75
32	0.80	44.90	45.14	90.04	3526.10	162.67
31	0.95	53.24	41.81	95.04	3436.06	162.58
30	1.07	60.17	39.03	99.20	3341.01	162.50
29	1.18	66.11	36.66	102.77	3241.81	162.42
28	1.27	70.88	34.75	105.63	3139.04	162.33
27	1.36	75.88	32.75	108.63	3033.42	162.25
26	1.45	81.43	30.53	111.96	2924.79	162.17
25	1.52	85.38	28.95	114.33	2812.83	162.08
24	1.58	88.61	27.66	116.27	2698.50	162.00
23	1.64	91.97	26.31	118.28	2582.23	161.92
22	1.70	95.17	25.03	120.20	2463.95	161.83
21	1.75	98.16	23.84	122.00	2343.74	161.75
20	1.80	100.96	22.72	123.68	2221.74	161.67
19	1.85	103.88	21.55	125.43	2098.07	161.58
18	1.89	106.01	20.70	126.71	1972.64	161.50
17	1.93	108.30	19.78	128.08	1845.93	161.42
16	1.97	110.60	18.86	129.46	1717.84	161.33
15	2.01	112.56	18.08	130.63	1588.38	161.25
14	2.04	114.52	17.29	131.81	1457.75	161.17
13	2.07	116.20	16.62	132.82	1325.94	161.08
12	2.10	117.88	15.95	133.83	1193.12	161.00
11	2.13	119.38	15.35	134.73	1059.29	160.92
10	2.15	120.62	14.85	135.47	924.56	160.83
9	2.18	121.92	14.33	136.25	789.09	160.75
8	2.20	123.11	13.86	136.97	652.84	160.67
7	2.21	123.61	13.66	137.27	515.87	160.58
6	0.00	0.00	63.10	63.10	378.61	160.50
5	0.00	0.00	63.10	63.10	315.51	160.42
4	0.00	0.00	63.10	63.10	252.40	160.33
3	0.00	0.00	63.10	63.10	189.30	160.25
2	0.00	0.00	63.10	63.10	126.20	160.17
1	0.00	0.00	63.10	63.10	63.10	160.08

2,582 CF exceeds required 2,541 CF of WQV

StormTech®

Detention - Retention - Water Quality

Division of ADS

STORMTECH ISOLATOR ROW SIZING CHART					
	SC-310	**SC-740**	**DC-780**	**MC-3500**	**MC-4500**
Chamber Area (Sq.Ft.)	20	27.8	27.8	43.2	30.1
Treated Flow Rate per chamber (CFS)	0.11	0.15	0.15	0.24	0.17

NOTE: *Testing of the Isolator Row completed by Tennesse Tech has been verified by NJCAT and it has shown to have a TSS removal efficiency of 84% for SIL-CO-SIL 250*

NJCAT verified Treated Flow Rate (GPM / Sq.Ft.) 2.5

.80 CFS Peak Flow Rate to be treated. 0.80 cfs / .15 cfs per chamber = 5.33 chambers

Infiltration System designed with 8 rows of 7 chambers per row

Water Quality Unit Sizing

Stormceptor Design Summary

PCSWMM for Stormceptor

Project Information

Date	8/3/2015
Project Name	AMC South Parking Lot Redevelopment
Project Number	12642.00
Location	Framingham/Natick, MA

Designer Information

Company	VHB
Contact	Peter Hitchko

Notes

DP 1 - Proposed Subcatchments 10, 11a, 11c

Drainage Area

Total Area (ac)	1.11
Imperviousness (%)	82

The Stormceptor System model STC 900 achieves the water quality objective removing 81% TSS for a NJDEP (clay, silt, sand) particle size distribution; providing continuous positive treatment for a stormwater quality flow rate of 1.04 cfs.

Rainfall

Name	BOSTON WSFO AP
State	MA
ID	770
Years of Records	1948 to 2005
Latitude	42°21'38"N
Longitude	71°0'38"W

Water Quality Objective

TSS Removal (%)	80
WQ Flow Rate (cfs)	1.04

Upstream Storage

Storage (ac-ft)	Discharge (cfs)
0	0

Stormceptor Sizing Summary

Stormceptor Model	TSS Removal %
STC 450i	73
STC 900	**81**
STC 1200	81
STC 1800	81
STC 2400	85
STC 3600	86
STC 4800	88
STC 6000	89
STC 7200	91
STC 11000	93
STC 13000	93
STC 16000	95

Particle Size Distribution

Removing silt particles from runoff ensures that the majority of the pollutants, such as hydrocarbons and heavy metals that adhere to fine particles, are not discharged into our natural water courses. The table below lists the particle size distribution used to define the annual TSS removal.

NJDEP (clay, silt, sand)

Particle Size µm	Distribution %	Specific Gravity	Settling Velocity ft/s		Particle Size µm	Distribution %	Specific Gravity	Settling Velocity ft/s
1	5	2.65	0.0012					
4	15	2.65	0.0012					
29	25	2.65	0.0025					
75	15	2.65	0.0133					
175	30	2.65	0.0619					
375	5	2.65	0.1953					
750	5	2.65	0.4266					

Stormceptor Design Notes

- Stormceptor performance estimates are based on simulations using PCSWMM for Stormceptor.
- Design estimates listed are only representative of specific project requirements based on total suspended solids (TSS) removal.
- Only the STC 450i is adaptable to function with a catch basin inlet and/or inline pipes.
- Only the Stormceptor models STC 450i to STC 7200 may accommodate multiple inlet pipes.
- Inlet and outlet invert elevation differences are as follows:

Inlet and Outlet Pipe Invert Elevations Differences

Inlet Pipe Configuration	STC 450i	STC 900 to STC 7200	STC 11000 to STC 16000
Single inlet pipe	3 in.	1 in.	3 in.
Multiple inlet pipes	3 in.	3 in.	Only one inlet pipe.

- Design estimates are based on stable site conditions only, after construction is completed.
- Design estimates assume that the storm drain is not submerged during zero flows. For submerged applications, please contact your local Stormceptor representative.
- Design estimates may be modified for specific spills controls. Please contact your local Stormceptor representative for further assistance.
- For pricing inquiries or assistance, please contact Rinker Materials 1 (800) 909-7763 www.rinkerstormceptor.com

Stormceptor Design Summary

PCSWMM for Stormceptor

Project Information

Date	8/3/2015
Project Name	AMC South Parking Lot Redevelopment
Project Number	12642.00
Location	Framingham/Natick, MA

Designer Information

Company	VHB
Contact	Peter Hitchko

Notes

DP 1 - Proposed Subcatchments 10

Drainage Area

Total Area (ac)	2.29
Imperviousness (%)	80

The Stormceptor System model STC 450i achieves the water quality objective removing 64% TSS for a NJDEP (clay, silt, sand) particle size distribution; providing continuous positive treatment for a stormwater quality flow rate of 2.11 cfs.

Rainfall

Name	BOSTON WSFO AP
State	MA
ID	770
Years of Records	1948 to 2005
Latitude	42°21'38"N
Longitude	71°0'38"W

Water Quality Objective

TSS Removal (%)	44
WQ Flow Rate (cfs)	2.11

Upstream Storage

Storage (ac-ft)	Discharge (cfs)
0	0

Stormceptor Sizing Summary

Stormceptor Model	TSS Removal %
STC 450i	**64**
STC 900	73
STC 1200	73
STC 1800	73
STC 2400	78
STC 3600	79
STC 4800	82
STC 6000	83
STC 7200	85
STC 11000	89
STC 13000	89
STC 16000	91

Particle Size Distribution

Removing silt particles from runoff ensures that the majority of the pollutants, such as hydrocarbons and heavy metals that adhere to fine particles, are not discharged into our natural water courses. The table below lists the particle size distribution used to define the annual TSS removal.

NJDEP (clay, silt, sand)

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1	5	2.65	0.0012					
4	15	2.65	0.0012					
29	25	2.65	0.0025					
75	15	2.65	0.0133					
175	30	2.65	0.0619					
375	5	2.65	0.1953					
750	5	2.65	0.4266					

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- Design estimates may be modified for specific spills controls. Please contact your local Stormceptor representative for further assistance.
- For pricing inquiries or assistance, please contact Rinker Materials 1 (800) 909-7763 www.rinkerstormceptor.com

Long Term Pollution Prevention Plan

Project Information

Site

Shoppers World
Shoppers World Drive
Framingham/Natick, MA

Owner

BRE DDR Shoppers World LLC
3300 Enterprise Parkway
Beachwood, OH 44122

Site Supervisor

Mark Harwood
BRE DDR Shoppers World LLC
3300 Enterprise Parkway
Beachwood, OH 44122

Site Contact

Name: _____

Telephone: _____

Cell phone: _____

Email: _____

Long-Term Pollution Prevention and Operation and Maintenance Plan

This Long-Term Pollution Prevention Plan has been developed to establish site management practices that improve the quality of stormwater discharges from the Project.

Long Term Stormwater Maintenance Measures

The following maintenance program is proposed to ensure the continued effectiveness of the structural water quality controls previously described.

- Clean all catch basins quarterly to remove accumulated sand, sediment, and floatable products or as needed based on use.
- Routinely pick up and remove litter from the parking areas, islands and perimeter landscape areas in addition to regular pavement sweeping.
- Routinely inspect all dumpster and compactor locations for spills. Remove all trash litter from the enclosure and dispose of properly.
- Street Sweeping (Standard Pavement): Sweep or vacuum roads and parking areas at least twice a year.

Pollutant Control Approach

Maintenance of Pavement Systems

Standard Asphalt Pavement

Regular maintenance of pavement surfaces will prevent pollutants such as oil and grease, trash, and sediments from entering the stormwater management system. The following practices should be performed:

- Routinely pick up and remove litter from the parking areas, islands, and perimeter landscaping.

Structural Stormwater Management Devices

Catch Basins

The proper removal of sediments and associated pollutants and trash occurs only when catch basin inlets and sumps are cleaned out regularly. The more frequent the cleaning, the less likely sediments will be re-suspended and subsequently discharged. In addition, frequent cleaning also results in more volume available for future deposition and enhances the overall performance. As noted in the pavement Operation and Maintenance (O&M) section, more frequent sweeping of paved surfaces will result in less accumulation in catch basins, less cleaning of subsurface structures, and less disposal costs.

There are eight (8) catch basins at Shoppers World. These catch basins are constructed with sumps (minimum 4 feet) and hooded outlets to trap debris, sediments, and floating contaminants. Disposal of all sediments must be in accordance with applicable local, state, and federal guidelines. A map of the catch basin locations is included in Appendix D.

Inspections and Cleaning

- All catch basins shall be inspected at least four times per year and cleaned a minimum of at least once per year.
- Sediment (if more than six inches deep) and/or floatable pollutants shall be pumped from the basin and disposed of at an approved offsite facility in accordance with all applicable regulations.
- Any structural damage or other indication of malfunction will be reported to the site manager and repaired as necessary
- During colder periods, the catch basin grates must be kept free of snow and ice.
- During warmer periods, the catch basin grates must be kept free of leaves, litter, sand, and debris.

Structural Water Quality Devices

- Inspect devices monthly for the first three months after construction.
- After initial three month period, all water quality units are to be inspected at least four times per year and cleaned a minimum of at least once per year or when sediment reaches 8" in depth.
- Follow manufacturer instructions for inspection and cleaning and contact manufacturer if system is malfunctioning.

Subsurface Infiltration Basins

The subsurface infiltration/detention basins are used to detain and infiltrate roadway and rooftop runoff. There are two (2) subsurface infiltration basins at Shoppers World. Subsurface Infiltration Basin (1) has a water quality pre-treatment device in the form of a subsurface sediment removal row to protect the infiltration bed from clogging. The sediment removal row is an integral part of the underground infiltration system and is comprised of a perforated pipe, wrapped in a filter fabric and surrounded with gravel. To maintain pre-treatment functionality, this sediment removal row requires regular inspection and cleaning. A map of the infiltration basin locations is included in Appendix D.

Inspections and Cleaning

- The subsurface infiltration systems will be inspected every 6 months during the first year and annually after the first year by removing the manhole/access port covers and determining the thickness of sediment that has accumulated in the sediment removal row.
- If sediment is more than six inches deep, it must be suspended via flushing with clean water and removed using a vactor truck.
- Manufacturer's specifications and instructions for cleaning the sediment removal row are provided as an attachment to this section.
- Emergency overflow pipes will be examined at least once each year and verified that no blockage has occurred.
- System will be observed after rainfalls to see if it is properly draining.

Existing Stormwater Outfalls

- Inspect outfall locations monthly for the first three months after construction to ensure proper functioning and correct any areas that have settled or experienced washouts.
- Inspect outfalls annually after initial three month period.
- Annual inspections should be supplemented after large storms, when washouts may occur.
- Maintain vegetation around outfalls to prevent blockages at the outfall.
- Maintain rip rap pad below each outfall and replace any washouts.
- Remove and dispose of any trash or debris at the outfall.

Existing Detention Basin

- The grass on the side slopes and in the buffer areas should be mowed, and grass clippings, organic matter, and accumulated trash and debris removed, at least twice during the growing season.
- Eroded or barren spots should be reseeded immediately after inspection to prevent additional erosion and accumulation of sediment.

- Sediment should be removed from the basin as necessary. Removal procedures should not take place until the floor of the basin is thoroughly dry.

Inspections and Cleaning

- Detention basins should be inspected at least twice a year to ensure proper stabilization and function.
- Light equipment, which will not compact the underlying soil, should be used to remove the top layer.

Maintenance of Vegetated Areas

Proper maintenance of vegetated areas can prevent the pollution of stormwater runoff by controlling the source of pollutants such as suspended sediments, excess nutrients, and chemicals from landscape care products. Practices that should be followed under the regular maintenance of the vegetated landscape include:

- Inspect planted areas on a semi-annual basis and remove any litter.
- Maintain planted areas adjacent to pavement to prevent soil washout.
- Immediately clean any soil deposited on pavement.
- Re-seed bare areas; install appropriate erosion control measures when native soil is exposed or erosion channels are forming.
- Plant alternative mixture of grass species in the event of unsuccessful establishment.
- The grass vegetation should be cut to a height between three and four inches.
- Pesticide/Herbicide Usage – No pesticides are to be used unless a single spot treatment is required for a specific control application.
- Fertilizer usage should be avoided. If deemed necessary, slow release fertilizer should be used. Fertilizer may be used to begin the establishment of vegetation in bare or damaged areas, but should not be applied on a regular basis unless necessary.

Management of Snow and Ice

Storage and Disposal

Snow shall be stockpiled on standard pavement surfaces so sand and salt may be swept in the spring or removed as snow melts and drains through the stormwater management system. Recommended locations for snow storage are shown on the attached Snow Storage Plan. Key practices for the safe storage and disposal of snow include:

- Under no circumstances shall snow be disposed or stored in wetland resource areas.
- Under no circumstances shall snow be disposed or stored in stormwater basins, ponds, rain gardens, swales, channels, or trenches.

Salt and Deicing Chemicals

The amount of salt and deicing chemicals to be used on the site shall be reduced to the minimum amount needed to provide safe pedestrian and vehicle travel. The following practices should be followed to control the amount of salt and deicing materials that come into contact with stormwater runoff:

- Devices used for spreading salt and deicing chemicals should be capable of varying the rate of application based on the site specific conditions.
- Specific environmentally sensitive areas should be designated as no and/or reduced salt areas.
- Sand and salt should be stockpiled under covered storage facilities that prevent precipitation and adjacent runoff from coming in contact with the deicing materials

Spill Prevention and Response Plan

Spill prevention equipment and training will be provided by the property management company.

Initial Notification

In the event of a spill the facility and/or construction manager or supervisor will be notified immediately.

Facility Manager* (name): _____

Facility Manager* (phone): _____

Construction Manager* (name): _____

Construction Manager* (phone): _____

The supervisor will first contact the Fire Department and then notify the Police Department, the Public Health Commission and the Conservation Commission. The Fire Department is ultimately responsible for matters of public health and safety and should be notified immediately.

* Contact information will be determined once contractor has been selected.

Further Notification

Based on the assessment from the Fire Chief, additional notification to a cleanup contractor may be made. The STATE Department of Environmental Protection (DEP)/Department of Environmental Services (DES) and the EPA may be notified depending upon the nature and severity of the spill. The Fire Chief will be responsible for determining the level of cleanup and notification required. The attached list of emergency phone numbers shall be posted in the main construction/facility office and readily accessible to all employees. A hazardous waste spill report shall be completed as necessary using the attached form.

Emergency Notification Phone Numbers*

1.	FACILITY MANAGER NAME: _____ ALTERNATE CONTACT: NAME: _____	PHONE:_____ BEEPER/CELL: _____, _____ HOME PHONE: _____ PHONE:_____ BEEPER/CELL: _____, _____ HOME PHONE: _____
2.	FIRE & POLICE DEPARTMENT	EMERGENCY: **911**
3.	CLEANUP CONTRACTOR: _____ ADDRESS: _____ _____	PHONE:_____
4.	STATE DEPARTMENT OF ENVIRONMENTAL PROTECTION (DEP)/DEPARTMENT OF ENVIRONMENTAL SERVICES (DES)	EMERGENCY PHONE: **(888) 304-1133**
5.	NATIONAL RESPONSE CENTER ALTERNATE: U.S. ENVIRONMENTAL PROTECTION AGENCY	PHONE: (800) 424-8802 EMERGENCY: **(888) 372-7341** BUSINESS: **(888) 372-7341**
6.	**FRAMINGHAM TOWN HEALTH DEPARTMENT** **FRAMINGHAM CONSERVATION COMMISSION:** **NATICK HEALTH DEPARTMENT:** **NATICK CONSERVATION COMMISSION:**	PHONE: **(508)-532-5470** PHONE: **(508)-532-5460** PHONE: **(508)-647-6460** PHONE: **(508)-647-6400**

* Contact information will be determined once contractor has been selected.

Hazardous Waste / Oil Spill Report

Date: ____/____/_____ Time: _____ AM / PM

Exact location _____

_____

Type of equipment:_____ Make:_____ Size:_____

License or S/N:_____ Weather Conditions:_____

On or near water

- Yes If yes, name of body of water:
- No

Type of chemical / oil spilled:

_____

_____

Amount of chemical / oil spilled:

_____

_____

Cause of spill:

_____

_____

Measures taken to contain or clean up spill:

_____

_____

Amount of chemical / oil recovered: _____ Method:_____

Material collected as a result of clean up

drums containing: _____

Location and method of debris disposal:

_____

_____

Name and address of any person, firm, or corporation suffering damages:_____

_____

_____

Procedures, method, and precautions instituted to prevent a similar occurrence from recurring: _____

_____

_____

Spill reported to General Office by:_____Time: _____AM / PM

Spill reported to DEP / National Response Center by:_____

DEP Date: _____/_____/_____ Time:_____AM / PM Inspector:_____

NRC Date: _____/_____/_____ Time:_____AM / PM Inspector: _____

Additional comments:

_____

_____

_____

_____

Assessment - Initial Containment

The supervisor or manager will assess the incident and initiate containment control measures with the appropriate spill containment equipment included in the spill kit kept on-site. A list of recommended spill equipment to be kept on site is included on the following page.

Fire / Police Department:	**911**
Framingham Health Department	**(508)-532-5470**
Framingham Conservation Commission:	**(508)-532-5460**
Natick Health Department:	**(508)-647-6460**
Natick Conservation Commission:	**(508)-647-6400**

Emergency Response Equipment

The following equipment and materials shall be maintained at all times and stored in a secure area for long-term emergency response need.

Supplies	***Recommended Suppliers***
➢ *SORBENT PILLOWS/"PIGS"* ***2***	*http://www.newpig.com*
➢ *SORBENT BOOM/SOCK* ***25 FEET***	*Item # KIT276 — mobile container with two pigs, 26*
➢ *SORBENT PADS* ***50***	*feet of sock, 50 pads, and five pounds of absorbent*
➢ *LITE-DRI® ABSORBENT* ***5***	*(or equivalent)*
POUNDS	*http://www.forestry-suppliers.com*
➢ *SHOVEL* ***1***	*Item # 43210 — Manhole cover pick (or equivalent)*
➢ *PRY BAR* ***1***	*Item # 33934 — Shovel (or equivalent)*
➢ *GOGGLES* ***1 PAIR***	*Item # 90926 — Gloves (or equivalent)*
➢ *GLOVES – HEAVY* ***1 PAIR***	*Item # 23334 — Goggles (or equivalent)*

Long Term O&M Checklist

Inspection Date: ____/____/____ Inspection Performed By: _____

Catch Basins – Inspect 4 times per year, clean when sediment depth >6 inches or at least once per year

Catch Basin	Inspected (Y/N)	Sediment Depth (inches)	Cleaning needed (Y/N)	Date Cleaned	Comments (Trash, Oil, Pet waste, Lawn Debris, Damaged)
DCB A1				/ /	
CB B1				/ /	
CB B3				/ /	
CB B6				/ /	
CB C1				/ /	
DCB C4				/ /	
EX CB C8				/ /	
EX CB C12				/ /	

Water Quality Units – Inspect 4 times per year, clean when sediment depth >8 inches or at least once per year. Inspect devices monthly for the first three months after construction.

Catch Basin	Inspected (Y/N)	Sediment Depth (inches)	Cleaning needed (Y/N)	Date Cleaned	Comments (Trash, Oil, Pet waste, Lawn Debris, Damaged)
WQU B7				/ /	
WQU C10				/ /	

Existing Outfalls – Inspect annually, replace any dislodged rip-rap, remove excess vegetation, remove any debris. Inspect monthly for first three months after construction.

Outfall	Inspected (Y/N)	Sediment Depth (inches)	Cleaning needed (Y/N)	Date Cleaned	Comments (Trash, Oil, Pet waste, Lawn Debris, Damage)
OF 1				/ /	
OF 2				/ /	
OF 3				/ /	
OF 4				/ /	
OF 5				/ /	
OF 6				/ /	

Inspection Date: ____/____/____ Inspection Performed By: _____

Existing Detention Basin – Inspect twice per year, remove sediment if more than 6 inches has accumulated in sediment collection row.					
Basin	Inspected (Y/N)	Sediment Depth (inches)	Cleaning needed (Y/N)	Date Cleaned	Comments (Trash, Oil, Sediment, Damage)
Existing Wet Basin 1				/ /	
Existing Wet Basin 2				/ /	

Subsurface Infiltration System – Inspect once per year, remove sediment if more than 3 inches has accumulated in sediment collection row. Inspect every 6 months for first year after construction					
Basin	Inspected (Y/N)	Sediment Depth (inches)	Cleaning needed (Y/N)	Date Cleaned	Comments (Trash, Oil, Sediment, Damage)
Infiltration Basin 1				/ /	
Infiltration Basin 2				/ /	

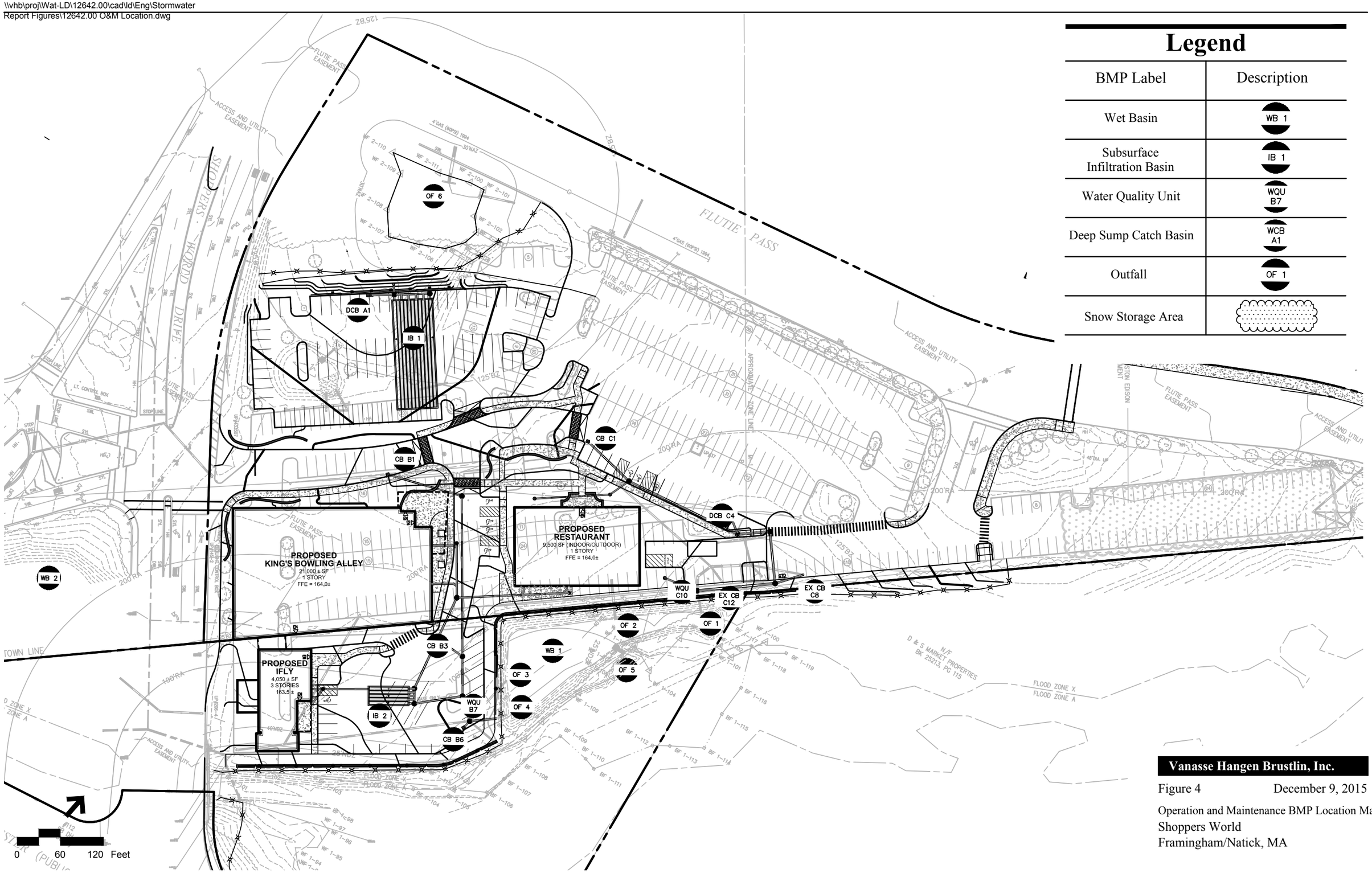
Overall Site – Mechanical Sweeping – Conducted at least twice a year					
Site	Inspected (Y/N)	Sediment Depth (inches)	Cleaning needed (Y/N)	Date Cleaned	Comments (Trash, Oil, Sediment, Damage)
Site				/ /	

Figure 4
Operation and Maintenance BMP Location Map

\\vhb\proj\Wat-LD\12642.00\cad\ld\Eng\Stormwater Report Figures\12642.00 O&M Location.dwg

Legend

BMP Label	Description
Wet Basin	WB 1
Subsurface Infiltration Basin	IB 1
Water Quality Unit	WQU B7
Deep Sump Catch Basin	WCB A1
Outfall	OF 1
Snow Storage Area	



Vanasse Hangen Brustlin, Inc.

Figure 4 December 9, 2015

Operation and Maintenance BMP Location Map
Shoppers World
Framingham/Natick, MA

Appendix E
Standard 7 Supporting Information

Included in this section:

- Redevelopment Checklist

Chapter 3

Checklist for Redevelopment Projects

Standard 7: A redevelopment project is required to meet the following Stormwater Management Standards only to the maximum extent practicable: Standard 2, Standard 3, and the pretreatment and structural stormwater best management practice requirements of Standards 4, 5, and 6. Existing stormwater discharges shall comply with Standard 1 only to the maximum extent practicable. A redevelopment project shall also comply with all other requirements of the Stormwater Management Standards and improve existing conditions.

Redevelopment is defined to include

- Maintenance and improvement of existing roadways, including widening less than a single lane, adding shoulders, correcting substandard intersections, improving existing drainage systems, and repaving;
- Development rehabilitation, expansion and phased projects on previously developed sites, provided the redevelopment results in no net increase in impervious area; and
- Remedial projects specifically designed to provide improved stormwater management, such as projects to separate storm drains and sanitary sewers, and stormwater retrofit projects.

Components of redevelopment projects that include development of previously undeveloped sites do not meet this definition. The portion of the project located in a previously developed area must meet Standard 7, but project components within undeveloped areas must meet all the Standards.

MassDEP recognizes that site constraints often make it difficult to comply with all the Standards at a redevelopment site. These constraints are as follows:

Lack of space. Because of the presence of existing structures, on-site subsurface sewage disposal systems, stormwater best management practices, and water bodies and wetlands, and easements, the space available for the installation of additional stormwater BMPs may be quite limited. On many suites it may be difficult or impossible to use space-intensive BMPs such as wet detention basins.

Soils: The presence of bedrock or clay can limit the effectiveness of infiltration or detention BMPs. Often soils at redevelopment sites have been compacted by buildings and heavy traffic, impairing their ability to infiltrate stormwater into the ground.

Underground utilities. The presence of underground utilities including gas and water mains, sewer pipes and electric cable conduits can greatly reduce the amount of land available for BMPs.

This chapter provides specific guidance and checklists to ensure that the applicant has met his/her obligations under Standard 7. Because it may be difficult for a redevelopment project to comply with all the Stormwater Management Standards, Standard 7 provides that a redevelopment project is required to comply with the following Standards only "to the maximum extent practicable": Standard 2, Standard 3, and the pretreatment and structural stormwater best management practice requirements of Standards 4, 5, and 6. Existing outfalls shall be brought into compliance with Standard 1 only to the maximum extent practicable.

As set forth in Standard 7, the phrase "to the maximum extent practicable" means that:

(1) Proponents of redevelopment projects have made all reasonable efforts to meet the requirements of Standards 2 and 3 and the pretreatment and structural stormwater best management practices requirements of Standards 4, 5, and 6 and to bring existing outfalls into compliance with Standard 1.

(2) They have made a complete evaluation of possible stormwater management measures, including environmentally sensitive site design that minimizes land disturbance and impervious surfaces, low impact development techniques and structural stormwater BMPs; and

(3) If not in full compliance with Standard 1 for existing outfalls, Standards 2 and 3 and the pretreatment and structural stormwater best management practice requirements of Standards 4, 5, and 6, they are implementing the highest practicable level of stormwater management.

Generally, an alternative is practicable if it can be implemented within the site being redeveloped, taking into consideration cost, land area requirements, soils and other site constraints. However, offsite alternatives may also be practicable. Proponents must document the evaluation of practicable alternatives with sufficient information to support the conclusions of the analysis.

At the same time, stormwater runoff from redevelopment projects must be properly managed. To this end, Standard 7 provides that redevelopment projects shall comply with all other requirements of the Stormwater Management Standards, including, without limitation, the pollution prevention requirements of Standards 4, 5, and 6, the erosion and sedimentation control requirements of Standard 8, the operation and maintenance requirements of Standard 9, and the prohibition of illicit discharge set forth in Standard 10. Proponents must also improve existing conditions.

Proponents of redevelopment projects shall document their compliance with these requirements. To assist proponents and reviewers in determining whether a redevelopment project complies with Standard 7, MassDEP has prepared the following redevelopment checklist.

[*Proponents of MassHighway redevelopment projects and Conservation Commissions reviewing such projects may follow the guidelines for redevelopment provided in the MassHighway Stormwater Handbook for Highways and Bridges (May 2004 or latest version) in lieu of the guidance set forth in this chapter.*[1] *The MassHighway Stormwater Handbook was developed by the Massachusetts Highway Department and issued by joint correspondence of May 7, 2004 by MassHighway and MassDEP. It provides detailed guidance on the evaluation and implementation of stormwater management practices for MassHighway road and bridge redevelopment projects, including a methodology for screening and selecting Best Management Practices (BMPs). Proponents and reviewers of other public roadway redevelopment projects may find useful information in the MassHighway Stormwater Handbook*.]

[1] The MassHighway Handbook published in 2004 must be revised to make it consistent with this Handbook.

Redevelopment Checklist

Existing Conditions

- On-site: For all redevelopment projects, proponents should document existing conditions, including a description of extent of impervious surfaces, soil types, existing land uses with higher potential pollutant loads, and current onsite stormwater management practices.
- Watershed: Proponents should determine whether the project is located in a watershed or subwatershed, where flooding, low streamflow or poor water quality is an issue.

The Project

Is the project a redevelopment project?

- Maintenance and improvement of existing roadways
- Development of rehabilitation, expansion or phased project on redeveloped site, or
- Remedial stormwater project

For non-roadway projects, is any portion of the project outside the definition of redevelopment?

- Development of previously undeveloped area
- Increase in impervious surface

If a component of the project is not a redevelopment project, the proponent shall use the checklist set forth below to document that at a minimum the proposed stormwater management system fully meets each Standard for that component. The proponent shall also document that the proposed stormwater management system meets the requirements of Standard 7 for the remainder of the project.

The Stormwater Management Standards

The redevelopment checklist reviews compliance with each of the Stormwater Management Standards in order.

Standard 1: (Untreated discharges)
No new stormwater conveyances (e.g., outfalls) may discharge untreated stormwater directly to or cause erosion in wetlands or waters of the Commonwealth.
Same rule applies for new developments and redevelopments.

Full compliance with Standard 1 is required for new outfalls.

- What BMPs are proposed to ensure that all new discharges associated with the discharge are adequately treated?
- What BMPs are proposed to ensure that no new discharges cause erosion in wetlands or waters of the Commonwealth?
- Will the proposed discharge comply with all applicable requirements of the Massachusetts Clean Waters Act and the regulations promulgated thereunder at 314 CMR 3.00, 314 CMR 4.00 and 314 CMR 5.00?

Existing outfalls shall be brought into compliance with Standard 1 to the maximum extent practicable.

- Are there any existing discharges associated with the redevelopment project for which new treatment could be provided?
- If so, the proponent shall specify the stormwater BMP retrofit measures that have been considered to ensure that the discharges are adequately treated and indicate the reasons for adopting or rejecting those measures. (See Section entitled "Retrofit of Existing BMPs".)
- What BMPs have been considered to prevent erosion from existing stormwater discharges?

Standard 2: (Peak rate control and flood prevention)

Stormwater management systems must be designed so that post-development peak discharge rates do not exceed pre-development peak discharge rates. This Standard may be waived for land subject to coastal storm flowage.

Full compliance for any component that is not a redevelopment

Compliance to the Maximum Extent Practicable:

- Does the redevelopment design meet Standard 2, comparing post-development to pre-development conditions?
- If not, the applicant shall document an analysis of alternative approaches for meeting the Standard. (See Menu of Strategies to Reduce Runoff and Peak Flows and/or Increase Recharge Menu included at the end of this chapter.)

Improvement of existing conditions:

- Does the project reduce the volume and/or rate of runoff to less than current estimated conditions? Has the applicant considered all the alternatives for reducing the volume and/or rate of runoff from the site? (See Menu.)
- Is the project located within a watershed subject to damage by flooding during the 2-year or 10-year 24-hour storm event? If so, does the project design provide for attenuation of the 2-year and 10-year 24-hour storm event to less than current estimated conditions? Have measures been implemented to reduce the volume of runoff from the site resulting from the 2 year or 10 year 24 hour storm event? (See Menu.)
- Is the project located adjacent to a water body or watercourse subject to adverse impacts from flooding during the 100-year 24-hour storm event? If so, are portions of the site available to increase flood storage adjacent to existing Bordering Land Subject to Flooding (BLSF)?
- Have measures been implemented to attenuate peak rates of discharge during the 100-year 24-hour storm event to less than the peak rates under current estimated conditions? Have measures been implemented to reduce the volume of runoff from the site resulting from the 100-year 24-hour storm event? (See Menu.)

Standard 3: (Recharge to Ground water)

Loss of annual recharge to ground water shall be eliminated or minimized through the use of infiltration measures, including environmentally sensitive site design, low impact development techniques, best management practices, and good operation and maintenance. At a minimum, the annual recharge from the post-development site shall approximate the annual recharge from the pre-development conditions based on soil type. This Standard is met when the stormwater management system is designed to infiltrate the required recharge volume as determined in accordance with the Massachusettss Stormwater Handbook.

Full compliance for any component that is not a redevelopment

Compliance to the Maximum Extent Practicable:

- Does the redevelopment design meet Standard 3, comparing post-development to pre-development conditions?
- If not, the applicant shall document an analysis of alternative approaches for meeting the Standard?
- What soil types are present on the site? Is the site is comprised solely of C and D soils and bedrock at the land surface?
- Does the project include sites where recharge is proposed at or adjacent to an area classified as contaminated, sites where contamination has been capped in place, sites that have an Activity and Use Limitation (AUL) that precludes inducing runoff to the groundwater, pursuant to MGL Chapter 21E and the Massachusetts Contingency Plan 310 CMR 40.0000; sites that are the location of a solid waste landfill as defined in 310 CMR 19.000; or sites where groundwater from the recharge location flows directly toward a solid waste landfill or 21E site?[2]
- Is the stormwater runoff from a land use with a higher potential pollutant load?
- Is the discharge to the ground located within the Zone II or Interim Wellhead Protection Area of a public water supply?
- Does the site have an infiltration rate greater than 2.4 inches per hour?

Improvements to Existing Conditions:

- Does the project increase the required recharge volume over existing (developed) conditions? If so, can the project be redesigned to reduce the required recharge volume by decreasing impervious surfaces (make building higher, put parking under the building, narrower roads, sidewalks on only one side of street, etc.) or using low impact development techniques such as porous pavement?
- Is the project located within a basin or sub-basin that has been categorized as under high or medium stress by the Massachusetts Water Resources Commission, or where there is other evidence that there are rivers and streams experiencing low flow problems? If so, have measures been considered to replace the natural recharge lost as a result of the prior development? (See Menu.)
- Has the applicant evaluated measures for reducing site runoff? (See Menu.)

Standard 4: (80% TSS Removal)

Stormwater management systems must be designed to remove 80% of the average annual post-construction load of Total Suspended Solids (TSS). This standard is met when:

a. Suitable practices for source control and pollution prevention are identified in a long-term pollution prevention plan and thereafter are implemented and maintained;

b. Stormwater BMPs are sized to capture the required water quality volume determined in accordance with the Massachusetts Stormwater Handbook; and

c. Pretreatment is provided in accordance with the Massachusetts Stormwater Handbook.

Full compliance for any component that is not a redevelopment
Full compliance with the long-term pollution plan requirement for new developments and redevelopments.

- Has the proponent developed a long-term pollution plan that fully meets the requirements of Standard 4?
- Does the pollution prevention plan include the following source control measures?
    - Street sweeping

[2] A mounding analysis is needed if a site falls within this category. See Volume 3.

- Proper management of snow, salt, sand and other deicing chemicals
- Proper management of fertilizers, herbicides and pesticides
- Stabilization of existing eroding surfaces

Compliance to the Maximum Extent Practicable for the other requirements:

- Does the redevelopment design provide for treatment of all runoff from existing (as well as new) impervious areas to achieve 80% TSS removal? If 80% TSS removal is not achieved, has the stormwater management system been designed to remove TSS to the maximum extent practicable?
- Have the proposed stormwater BMPs been properly sized to capture the prescribed runoff volume?
  - One inch rule applies for discharge
    - within a Zone II or Interim Wellhead Protection Area,
    - near or to another critical area,
    - from a land use with a higher potential pollutant load
    - to the ground where the infiltration rate is greater than 2.4 inches per hour
- Has adequate pretreatment been proposed?
  - 44% TSS Removal Pretreatment Requirement applies if:
    - Stormwater runoff is from a land use with a higher potential pollutant load
    - Stormwater is discharged
      - To the ground within the Zone II or Interim Wellhead Protection Area of a Public Water Supply
      - To the ground with an infiltration rate greater than 2.4 inches per hour
      - Near or to an Outstanding Resource Water, Special Resource Water, Cold-Water Fishery, Shellfish Growing Area, or Bathing Beach.

- If the stormwater BMPs do not meet all the requirements set forth above, the applicant shall document an analysis of alternative approaches for meeting the these requirements. (See Section on Retrofitting Existing BMPs (the "Retrofit Section").

Improvements to Existing Conditions:

- Have measures been provided to achieve at least partial compliance with the TSS removal standard?
- Have any of the best management practices in the Retrofit Section been considered?
- Have any of the following pollution prevention measures been considered?
  - Reduction or elimination of winter sanding, where safe and prudent to do so
  - Tighter controls over the application of fertilizers, herbicides, and pesticides
  - Landscaping that reduces the need for fertilizer, herbicides and pesticides
  - High frequency sweeping of paved surfaces using vacuum sweepers
  - Improved catch basin cleaning
  - Waterfowl control programs
- Are there any discharges (new or existing) to impaired waters? If so, see TMDL section.

<u>Standard 5 (Higher Potential Pollutant Loads (HPPL)</u>

For land uses with higher potential pollutant loads, source control and pollution prevention shall be implemented in accordance with the Massachusetts Stormwater Handbook to eliminate or reduce the discharge of stormwater runoff from such land uses to the maximum extent practicable. If through source control and/or pollution prevention, all land uses with higher potential pollutant loads cannot

be completely protected from exposure to rain, snow, snow melt and stormwater runoff, the proponent shall use the specific stormwater BMPs determined by the Department to be suitable for such use as provided in the Massachusetts Stormwater Handbook. Stormwater discharges from land uses with higher potential pollutant loads shall also comply with the requirements of the Massachusetts Clean Waters Act, M.G.L. c. 21, §§ 26-53, and the regulations promulgated thereunder at 314 CMR 3.00, 314 CMR 4.00 and 314 CMR 5.00.
Full compliance for any component that is not a redevelopment.
Full compliance with pollution prevention requirements for new developments and redevelopments.

Pollution Prevention

- Has the proponent considered any of the following operational source control measures?
    - Formation of a pollution prevention team,
    - Good housekeeping practices,
    - Preventive maintenance procedures,
    - Spill prevention and clean up,
    - Employee training, and
    - Regular inspection of pollutant sources.

- Has the proponent considered implementation of any of the following operational changes to reduce the quantity of pollutants on site?
    - Process changes,
    - Raw material changes,
    - Product changes, or
    - Recycling.

- Has the proponent considered making capital improvements to protect the land uses with higher potential pollutant loads from exposure to rain, snow, snow melt, and stormwater runoff?

    - Enclosing and/or covering pollutant sources (e.g. placing pollutant sources within a building or other enclosure, placing a roof over storage and working areas, placing tarps under pollutant source)

    - Installing a containment system with an emergency shutoff to contain spills?

    - Physically segregating the pollutant source to prevent run-on of uncontaminated stormwater?

Treatment

- If applicable, compliance with the treatment and pretreatment requirements of Standard 5 only to the Maximum Extent Practicable by directing the stormwater runoff from land uses with higher potential pollutant loads to appropriate stormwater BMPs?

    - Are the BMPs selected capable of removing the pollutants associated with the higher potential pollutant load land ("LUHPPL") use?

    - Is the land use likely to generate stormwater with high concentrations of oil and grease? If so has an oil grit separator, sand filter, filtering bioretention area or equivalent been proposed for pretreatment?

Improvement of Existing Conditions.

- If the redevelopment converts a site from a non-LUHPPL use to a LUHPPL use, the applicant shall document how the stormwater BMPs shall be modified or replaced to come into compliance with Standard 5.

- What specific measures have been considered to offset the anticipated impacts of land uses with higher potential pollutant loads?

- If the redevelopment proposal is a brownfield project, the applicant shall demonstrate how the stormwater management measures have been designed to prevent mobilization or remobilization of soil and groundwater contamination. (See Brownfield section)

Other Requirements

- Does the discharge comply with all applicable requirements of the Massachusetts Clean Waters Act, 314 CMR 3.00, 314 CMR 4.00 and 314 CMR 5.00?

Standard 6 (Critical Areas)

Stormwater discharges to a Zone II or Interim Wellhead Protection Area of a public water supply and stormwater discharges near or any other critical area require the use of the specific source control and pollution prevention measures and the specific stormwater best management practices determined by the Department to be suitable for managing discharges to such area, as provided in the Massachusetts Stormwater Handbook. A discharge is near a critical area if there is a strong likelihood of a significant impact occurring to said area, taking into account site-specific factors. Stormwater discharges to Outstanding Resource Waters or Special Resource Waters shall be set back from the receiving water and receive the highest and best practical method of treatment. A "stormwater discharge," as defined in 314 CMR 3.04(2)(a)1. or (b), to an Outstanding Resource Water or Special Resource Water shall comply with 314 CMR 3.00 and 314 CMR 4.00. Stormwater discharges to a Zone I or Zone A are prohibited unless essential to the operation of the public water supply.

Full compliance for component of project that is not a redevelopment
Full compliance with pollution prevention requirements for new developments and redevelopments.

If applicable, compliance to the Maximum Extent Practicable with the pretreatment and treatment requirements of Standard 6:

- Does the redevelopment project utilize the pretreatment, treatment and infiltration BMPs approved for discharges near or to critical areas?
- If the redevelopment project does not comply with Standard 6, the applicant shall document an analysis of alternative measures for meeting Standard 6. (See Section on Specific Redevelopment Projects.)

Improvements to Existing Conditions:

- Have measures to protect critical areas been considered, including additional pollution prevention measures and structural and non-structural BMPs?

Other Requirements

- Does the discharge comply with the Massachusetts Clean Waters Act, 314 CMR 3.00, 314 CMR 4.00, and 314 CMR 5.00?

Standard 8: (Erosion, Sediment Control)

A plan to control construction-related impacts, including erosion sedimentation and other pollutant sources during construction and land disturbance activities (construction period erosion, sedimentation, and pollution prevention plan), must be developed and implemented.

All redevelopment projects shall fully comply with Standard 8.

- Has the proponent submitted a construction period erosion, sedimentation and pollution prevention plan that meets the requirements of Standard 8?

Standard 9: (Operation and Maintenance)
A long-term operation and maintenance plan must be developed and implemented to ensure that stormwater management systems function as designed.
All redevelopment projects shall fully comply with Standard 9.

- Has the proponent submitted a long-term Operation and Maintenance plan that meets the requirements of Standard 9?

Standard 10 (Illicit Discharges)
All illicit discharges to the stormwater management system are prohibited.
All redevelopment projects shall fully comply with Standard 10.

- Are there any known or suspected illicit discharges to the stormwater management system at the redevelopment project site?
- Has an illicit connection detection program been implemented using visual screening, dye or smoke testing?
- Have an Illicit Discharge Compliance Statement and associated site map been submitted verifying that there are no illicit discharges to the stormwater management system at the site?

Improvements to Existing Conditions:

- Once all illicit discharges are removed, has the proponent implemented any measures to prevent additional illicit discharges?

Figure 5-1

Menu of Strategies to Reduce Runoff or Peak Flows and/or Increase Recharge

- Rehabilitate the soils
- Plant trees and other vegetation
- Install a green roof
- Maximize naturally vegetated areas
- Reduce impervious surfaces
- Disconnect roof runoff from direct discharge to the drainage system
- Disconnect other existing paved areas from direct discharge to the drainage system, allowing controlled flow over pervious areas or through BMPs providing at least partial recharge
- Install porous pavement and/or other recharge measures (where sustainable and maintainable for promoting infiltration)
- Apply LID techniques for runoff reduction
- Install additional structural BMPs that are appropriate for redevelopment sites including infiltration trenches, subsurface structures, oil-grit separators, proprietary BMPs
- Retrofit existing BMPs

Retrofitting Existing BMPs

Many BMPs can be effectively retrofitted depending on site conditions and the water quantity or quality objectives trying to be achieved.[3] The objective of stormwater retrofitting is to remedy problems associated with, and improve water quality mitigation functions of, older, poorly designed, or poorly maintained stormwater management systems. Prior to the development of the stormwater standards, site drainage design did not require stormwater detention for controlling post-development peak flows. As a result, drainage, flooding, and erosion problems can be common in many older developed areas of the state. Furthermore, a majority of the dry detention basins throughout the state have been designed to control peak flows, without regard to water quality mitigation. Therefore, many existing dry detention basins provide only minimal water quality benefit. Incorporating stormwater retrofits into existing developed sites or into redevelopment projects can reduce the adverse impacts of uncontrolled stormwater runoff.

Bioretention Area Retrofits - can be used as a stormwater retrofit, by modifying existing landscaped areas, or if a parking lot is being resurfaced. In highly urban watersheds, they are one of the few practical retrofit options.

Catch Basin Retrofits or Reconstruction - Older catch basins without sumps can be replaced with catch basins having four foot-deep sumps. Sumps provide storage volume for coarse sediments, assuming that accumulated sediment is removed on a regular basis. Hooded outlets, which are covers over the catch basin outlets that extend below the standing water line, can also be used to trap litter and other floatable materials. Leaching catch basins can be installed adjacent to deep sump catch basins to achieve 80% TSS removal. Be aware, however, that many products are being touted as catch basin inserts, but the effectiveness of these devices can vary significantly.

Dry Detention Basin Retrofits - Traditional dry detention basins can be modified to become extended dry detention basins, wet basins, or constructed stormwater wetlands for enhanced pollutant removal. This is one of the most commonly and easily implemented retrofits, since it typically requires little or no additional land area, capitalizes on an existing facility for which there is already some resident acceptance of stormwater management, and involves minimal impacts to environmental resources (Claytor, Center for Watershed Protection, 2000).

There are numerous retrofit options that will enhance the removal of pollutants in detention basins:

- Excavate the basin bottom to create more permanent pool storage.
- Raise the basin embankment to obtain additional storage for extended detention.
- Modify the outfall structure to create a two-stage release to better control small storms while not significantly compromising flood control detention for large storms.
- Increase the flow path from inflow to outflow and eliminate short-circuiting by using baffles, earthen berms or micro-pond topography to increase residence time.
- Incorporate stilling basins at inlets and outlets.
- Regrade the basin bottom to create a wetland area near the basin outlet or revegetate parts of the basin bottom with wetland vegetation to enhance pollutant removal, reduce mowing, and improve aesthetics.
- Create a wetland shelf along the perimeter of a wet basin to improve shoreline stabilization, enhance pollutant filtering, and enhance aesthetic and habitat functions.
- Create a low maintenance "no-mow" wildflower ecosystem in the drier portions of the basin.

[3] Additional information on retrofitting stormwater BMPs can be found in the Urban Stormwater Retrofit Practices Manual. See http://www.cwp.org/Downloads/ELC_USRM3app.pdf.

- Provide a high flow bypass to avoid resuspension of captured sediments/pollutants during high flows.
- Eliminate low-flow bypasses.

Drainage Channel Retrofits - Existing channelized streams and drainage conveyances such as drainage channels can be modified to reduce flow velocities and enhance pollutant removal. Weir walls or riprap check dams placed across a channel create opportunities for ponding, infiltration, and establishment of wetland vegetation upstream of the retrofit. In-stream retrofit practices include stream bank stabilization of eroded areas and placement of habitat improvement structures (i.e., flow deflectors, boulders, pools/riffles, and low-flow channels) in natural streams and along stream banks. In-stream retrofits may require an evaluation of potential flooding and floodplain impacts resulting from altered channel conveyance, as well as requirements for local, state, or federal approval for work in wetlands and watercourses.

Parking Lots and Roadways- Parking lots offer ideal opportunities for a wide range of stormwater retrofits:

1. Incorporate bioretention areas into parking lot islands and landscaped areas; tree planter boxes can be converted into functional bioretention areas, rain gardens, or treebox filters to reduce and treat stormwater runoff.
2. Remove curbing and add slotted curb stops. Curbs along the edges of parking lots can sometimes be removed or slotted to re-route runoff to vegetated filter strips, water quality swales, grass channels, or bioretention facilities. The capacity of existing swales may need to be evaluated and expanded as part of this retrofit option.
3. Incorporate new treatment practices such as bioretention areas, sand filters, and constructed stormwater wetlands at the edges of parking lots.
4. In overflow parking or other low-traffic areas, asphalt can be replaced with porous pavement.

Sand Filter Retrofits - are suitable where space is limited, because they consume little surface space and have few site restrictions. Since sand filters cannot treat large drainage areas, retrofitting many small individual sites may be the only option. This option may be expensive.

Storm Drain Outfalls - New stormwater treatment practices can be constructed at the outfalls of existing drainage systems. The new stormwater treatment practices are commonly designed as *off-line devices* to treat the first flush volume and bypass larger storms. Water quality swales, bioretention areas, sand filters, constructed stormwater wetlands, and wet basins are commonly used for this type of retrofit. Other stormwater treatment practices may also be used if there is enough space for construction and maintenance.

Specific Redevelopment Projects

Redevelopment projects present unique challenges for controlling stormwater. It is possible that site constraints may prevent a redevelopment project from complying with one or more of the Stormwater Management Standards. Even if a redevelopment project cannot meet all of the Standards, there may be ample opportunity to improve existing site conditions depending on the other water quality or quantity issues in the watershed. The following special considerations provide unique opportunities for identifying how existing conditions may be improved:

A. Groundwater Recharge Areas - Redevelopment projects located within these areas (Zone II, Interim Wellhead Protection Areas (IWPA), aquifer protection districts, etc.) should place a high priority on ground water recharge BMPs.
   1) Disconnecting Rooftop Runoff – In some instances, building roof drains connected to the stormwater drainage system can be disconnected and re-directed to vegetated filter strips, bioretention facilities, or infiltration structures (dry wells or infiltration trenches).
   2) Use of Porous Paving Materials - Existing impermeable pavement in overflow parking or other low-traffic areas can sometimes be replaced with alternative permeable materials such as modular concrete paving blocks, modular concrete or plastic lattice, or cast-in-place concrete grids. Site-specific factors including traffic volumes, soil permeability, maintenance, sediment loads, and land use must be carefully considered prior to selection.

B. Cold-Water Fisheries - Redevelopment projects adjacent to these areas should place a high priority on mitigating potential thermal impacts. Techniques to consider include:

   1) Maintain Time of Concentration - Time of concentration (Tc) is based on the flow path and length, ground cover, slope and channel shape. When development occurs, Tc is often shortened due to the impervious area, causing greater flows to occur over a shorter period of time. Increasing the Tc will help to reduce the thermal impact of stormwater runoff from warm surface areas. Options to consider include:
      - Increasing the length of the runoff flow path
      - Increasing the surface roughness of the flow path
      - Detaining flows on site
      - Minimizing land disturbance
      - Creating flatter slopes.
   2) Disconnecting impervious areas – Breaking up large impervious expanses with vegetated zones will reduce the potential temperature increases of stormwater flowing across hot pavement.

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C. Brownfield Redevelopment – Redeveloping urban and non-urban brownfield sites (which in Massachusetts includes most "disposal sites" under the Massachusetts Contingency Plan [MCP]) are a Commonwealth priority, with ramifications for urban sprawl as well as the remediation of historically contaminated properties. Proponents of brownfield redevelopment projects should evaluate BMPs that will prevent the significant uncontrolled mobilization or remobilization of soil or ground water contamination. BMP considerations at these sites should consider such factors as:
   - The location of stormwater infiltration units with respect to contaminated areas
   - Ground water mounding effects on the rate and direction of migration of ground water contaminants
   - The location of outfalls
   - Water quality BMPs.

D. Runoff to Impaired Water Bodies – If MassDEP has issued a Total Maximum Daily Load (TMDL) that establishes a waste load allocation for stormwater discharge and/or a TMDL Implementation Plan that identifies remedies aimed at reducing the amount of pollutants from stormwater discharges, proponents may be required to install stormwater BMPs that are consistent with the TMDL.

E. Runoff to Areas of Localized Flooding – Project proponents must also understand the potential impacts of stormwater runoff in areas prone to localized flooding. When completing the checklist, proponents should consider the capacity of the receiving water and/or storm drainage system. When evaluating discharges to areas subject to localized flooding, the proponent should evaluate the ability to maintain and/or improve existing site cover and reduce runoff volume.

Appendix F
Standard 8 Supporting Information

Included in this section:

- Recommended Construction Period Pollution Prevention and Erosion and Sedimentation Controls
- Construction BMP Maintenance Checklist

Erosion and Sedimentation Control Measures

The following erosion and sedimentation controls are for use during the earthwork and construction phases of the project. The following controls are provided as recommendations for the site contractor and do not constitute or replace the final Stormwater Pollution Prevention Plan that must be fully implemented by the Contractor and owner in Compliance with EPA NPDES regulations.

Silt Fence

Silt Fence will be placed to trap sediment transported by runoff before it reaches the drainage system or leaves the construction site. Fence will be set at least 12 (twelve) inches into the existing ground to minimize undercutting by runoff.

Siltsock

In areas where high runoff velocities or high sediment loads are expected,silt sock will be backed up with silt fencing. This semi-permeable barrier made of a synthetic porous fabric will provide additional protection. The silt fences and silt sock barrier will be replaced as determined by periodic field inspections.

Compost Berms

Catch Basin Protection

Newly constructed and existing catch basins will be protected with hay bale barriers (where appropriate) or silt sacks throughout construction.

Gravel and Construction Entrance/Exit

A temporary crushed-stone construction entrance/exit will be constructed. A cross slope will be placed in the entrance to direct runoff to a protected catch basin inlet or settling area. If deemed necessary after construction begins, a wash pad may be included to wash off vehicle wheels before leaving the project site.

Construction BMP Maintenance Checklist

Shoppers World – Framingham/Natick, MA
Construction Best Management Practices – Maintenance/ Evaluation Checklist

Best Management Practice	Inspection Frequency	Date Inspected	Inspector	Minimum Maintenance and Key Items to Check	Cleaning/Repair Needed ☐yes ☐no (List Items)	Date of Cleaning/Repair	Performed by:
Silt Fence	Weekly and after storm events				☐yes ☐no		
Silt Sock	Weekly and after storm events				☐yes ☐no		
Gravel Construction Entrance	Weekly and after storm events				☐yes ☐no		
Catch Basin Protection	Weekly and after storm events				☐yes ☐no		
Vegetated Slope Stabilization	Weekly and after storm events				☐yes ☐no		
					☐yes ☐no		

Stormwater Control Manager _____

Appendix G
Standard 9 Supporting Information

Included in this section:

- Isolator Row Maintenance Manual
- Stormceptor maintenance manual
- Snow Storage Plan

Isolator Row Maintenance Manual

StormTech®

Detention • Retention • Water Quality

A division of ADS

Save Valuable Land and Protect Water Resources

Isolator® Row O&M Manual

StormTech® Chamber System for Stormwater Management

1.0 The Isolator® Row

1.1 INTRODUCTION

An important component of any Stormwater Pollution Prevention Plan is inspection and maintenance. The StormTech Isolator Row is a patented technique to inexpensively enhance Total Suspended Solids (TSS) removal and provide easy access for inspection and maintenance.

Looking down the Isolator Row from the manhole opening, woven geotextile is shown between the chamber and stone base.

1.2 THE ISOLATOR ROW

The Isolator Row is a row of StormTech chambers, either SC-310, SC-310-3, SC-740, DC-780, MC-3500 or MC-4500 models, that is surrounded with filter fabric and connected to a closely located manhole for easy access. The fabric-wrapped chambers provide for settling and filtration of sediment as storm water rises in the Isolator Row and ultimately passes through the filter fabric. The open bottom chambers and perforated sidewalls (SC-310, SC-310-3 and SC-740 models) allow storm water to flow both vertically and horizontally out of the chambers. Sediments are captured in the Isolator Row protecting the storage areas of the adjacent stone and chambers from sediment accumulation.

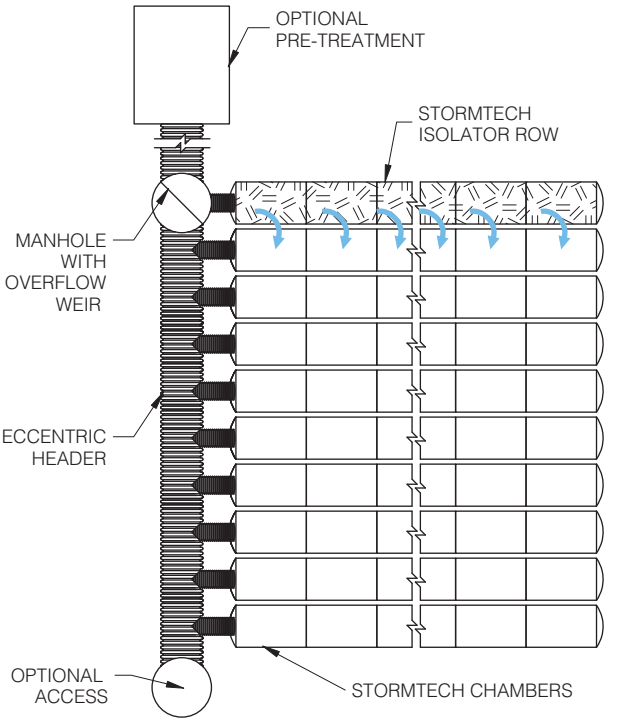
Two different fabrics are used for the Isolator Row. A woven geotextile fabric is placed between the stone and the Isolator Row chambers. The tough geotextile provides a media for storm water filtration and provides a durable surface for maintenance operations. It is also designed to prevent scour of the underlying stone and remain intact during high pressure jetting. A non-woven fabric is placed over the chambers to provide a filter media for flows passing through the perforations in the sidewall of the chamber. The non-woven fabric is not required over the DC-780, MC-3500 or MC-4500 models as these chambers do not have perforated side walls.

The Isolator Row is typically designed to capture the "first flush" and offers the versatility to be sized on a volume basis or flow rate basis. An upstream manhole not only provides access to the Isolator Row but typically includes a high flow weir such that storm water flowrates or volumes that exceed the capacity of the Isolator Row overtop the over flow weir and discharge through a manifold to the other chambers.

The Isolator Row may also be part of a treatment train. By treating storm water prior to entry into the chamber system, the service life can be extended and pollutants such as hydrocarbons can be captured. Pre-treatment best management practices can be as simple as deep sump catch basins, oil-water separators or can be innovative storm water treatment devices. The design of the treatment train and selection of pretreatment devices by the design engineer is often driven by regulatory requirements. Whether pretreatment is used or not, the Isolator Row is recommended by StormTech as an effective means to minimize maintenance requirements and maintenance costs.

Note: See the StormTech Design Manual for detailed information on designing inlets for a StormTech system, including the Isolator Row.

StormTech Isolator Row with Overflow Spillway
(not to scale)



2.0 Isolator Row Inspection/Maintenance

2.1 INSPECTION

The frequency of Inspection and Maintenance varies by location. A routine inspection schedule needs to be established for each individual location based upon site specific variables. The type of land use (i.e. industrial, commercial, residential), anticipated pollutant load, percent imperviousness, climate, etc. all play a critical role in determining the actual frequency of inspection and maintenance practices.

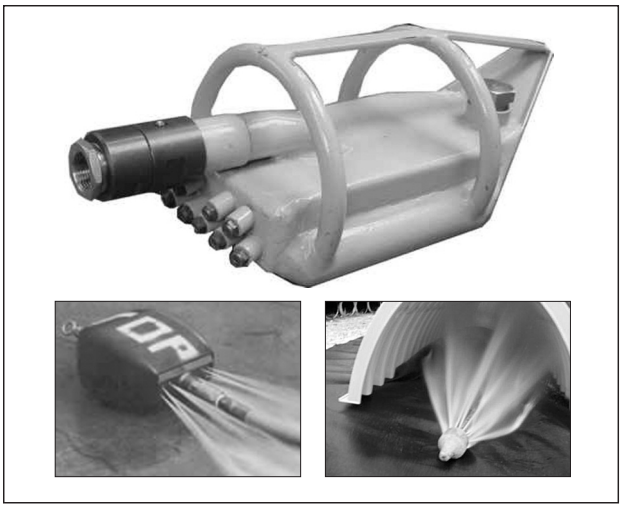
At a minimum, StormTech recommends annual inspections. Initially, the Isolator Row should be inspected every 6 months for the first year of operation. For subsequent years, the inspection should be adjusted based upon previous observation of sediment deposition.

The Isolator Row incorporates a combination of standard manhole(s) and strategically located inspection ports (as needed). The inspection ports allow for easy access to the system from the surface, eliminating the need to perform a confined space entry for inspection purposes.

If upon visual inspection it is found that sediment has accumulated, a stadia rod should be inserted to determine the depth of sediment. When the average depth of sediment exceeds 3 inches throughout the length of the Isolator Row, clean-out should be performed.

2.2 MAINTENANCE

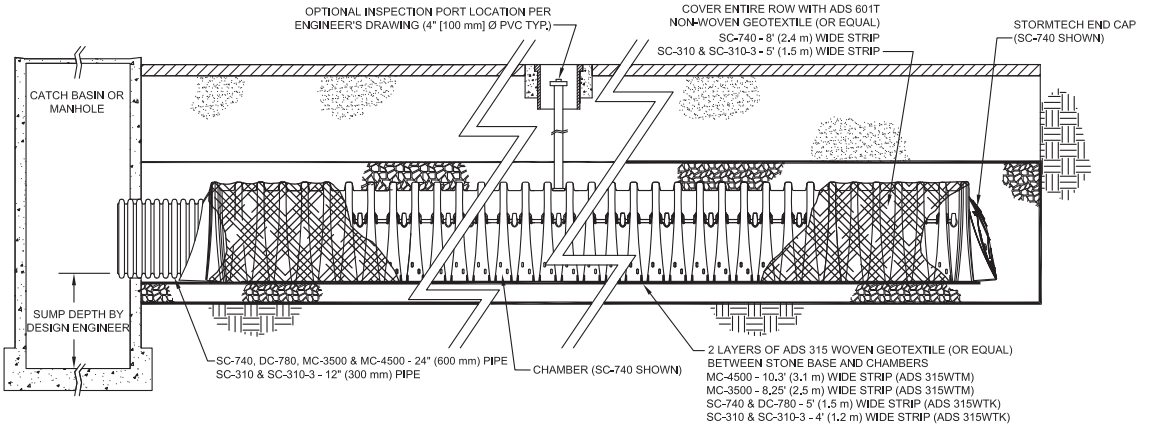
The Isolator Row was designed to reduce the cost of periodic maintenance. By "isolating" sediments to just one row, costs are dramatically reduced by eliminating the need to clean out each row of the entire storage bed. If inspection indicates the potential need for maintenance, access is provided via a manhole(s) located on the end(s) of the row for cleanout. If entry into the manhole is required, please follow local and OSHA rules for a confined space entries.



Examples of culvert cleaning nozzles appropriate for Isolator Row maintenance. (These are not StormTech products.)

Maintenance is accomplished with the JetVac process. The JetVac process utilizes a high pressure water nozzle to propel itself down the Isolator Row while scouring and suspending sediments. As the nozzle is retrieved, the captured pollutants are flushed back into the manhole for vacuuming. Most sewer and pipe maintenance companies have vacuum/JetVac combination vehicles. Selection of an appropriate JetVac nozzle will improve maintenance efficiency. Fixed nozzles designed for culverts or large diameter pipe cleaning are preferable. Rear facing jets with an effective spread of at least 45" are best. Most JetVac reels have 400 feet of hose allowing maintenance of an Isolator Row up to 50 chambers long. **The JetVac process shall only be performed on StormTech Isolator Rows that have AASHTO class 1 woven geotextile (as specified by StormTech) over their angular base stone.**

StormTech Isolator Row (not to scale)



NOTE: NON-WOVEN FABRIC IS ONLY REQUIRED OVER THE INLET PIPE CONNECTION INTO THE END CAP FOR DC-780, MC-3500 AND MC-4500 CHAMBER MODELS AND IS NOT REQUIRED OVER THE ENTIRE ISOLATOR ROW.

3.0 Isolator Row Step By Step Maintenance Procedures

Step 1) Inspect Isolator Row for sediment

A) Inspection ports (if present)

i. Remove lid from floor box frame

ii. Remove cap from inspection riser

iii. Using a flashlight and stadia rod, measure depth of sediment and record results on maintenance log.

iv. If sediment is at, or above, 3 inch depth proceed to Step 2. If not proceed to step 3.

B) All Isolator Rows

i. Remove cover from manhole at upstream end of Isolator Row

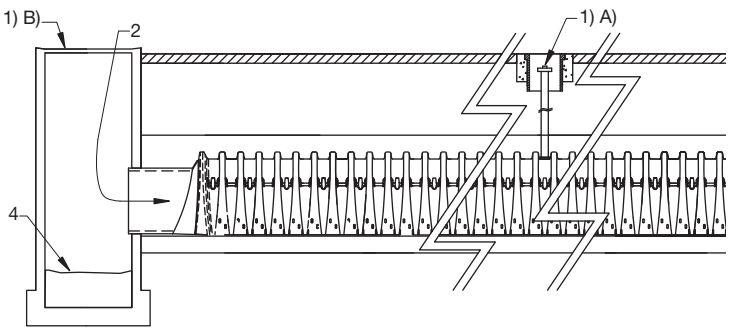
ii. Using a flashlight, inspect down Isolator Row through outlet pipe

1. Mirrors on poles or cameras may be used to avoid a confined space entry

2. Follow OSHA regulations for confined space entry if entering manhole

iii. If sediment is at or above the lower row of sidewall holes (approximately 3 inches) proceed to Step 2. If not proceed to Step 3.

StormTech Isolator Row (not to scale)



Step 2) Clean out Isolator Row using the JetVac process

A) A fixed culvert cleaning nozzle with rear facing nozzle spread of 45 inches or more is preferable

B) Apply multiple passes of JetVac until backflush water is clean

C) Vacuum manhole sump as required

Step 3) Replace all caps, lids and covers, record observations and actions

Step 4) Inspect & clean catch basins and manholes upstream of the StormTech system

Sample Maintenance Log

Date	Stadia Rod Readings		Sediment Depth (1) - (2)	Observations/Actions	Inspector
	Fixed point to chamber bottom (1)	Fixed point to top of sediment (2)			
3/15/01	6.3 ft.	none		New installation. Fixed point is CI frame at grade	djm
9/24/01		6.2	0.1 ft.	Some grit felt	sm
6/20/03		5.8	0.5 ft.	Mucky feel, debris visible in manhole and in Isolator row, maintenance due	rv
7/7/03	6.3 ft.		0	System jetted and vacuumed	djm

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Stormceptor Maintenance Manual

Inspection and Maintenance. Easy. Convenient.

When it rains, oils, sediment and other contaminants are captured and contained by over 20,000 Stormceptor units operating worldwide. While Stormceptor's patented scour prevention technology ensures captured pollutants remain in the unit during all rainfall events, the accumulated pollutants must eventually be removed as part of a regular maintenance program.

If neglected, oil and sediment gradually build up and diminish any BMP's efficiency, harming the environment and leaving owners and operators vulnerable to fines, surcharges and bad publicity.

Maintenance is a must

Ease, frequency and cost of maintenance are often overlooked by specifiers when considering the merits of a stormwater treatment system. In reality, maintenance is fundamental to the long-term performance of any stormwater quality treatment device.

While regular maintenance is crucial, it shouldn't be complicated. An ongoing maintenance program with Stormceptor is convenient and practically effortless. With virtually no disruptions, you can concentrate on your core business.

Quick inspections

Inspections are easily carried out above ground from any standard surface access cover through a visual inspection of the orifice and drop tee components. A sludge judge and oil dip-stick are all that are needed for sediment and oil depth measurements.

Easy unit access

Maintenance is typically conducted from the same surface access cover, eliminating the need for confined space entry into the unit. Your site remains undisturbed, saving you time and money.

No muss, no fuss and fast

Maintenance is performed quickly and inexpensively with a standard vacuum truck. Servicing usually takes less than two hours, with no disruption to your site.

A complete stormwater management plan for Stormceptor extends beyond installation and performance to regular maintenance. It's the smart, cost-effective way to ensure your unit continues to remove more pollutants than any other separator for decades to come.

Stormceptor maintenance recommendations

- Units should be inspected post-construction, prior to being put into service.
- Inspect every six months for the first year of operation to determine the oil and sediment accumulation rate.
- In subsequent years, inspections can be based on first-year observations or local requirements.
- Cleaning is required once the sediment depth reaches 15% of storage capacity, (generally taking one year or longer). Local regulations for maintenance frequency may vary.
- Inspect the unit immediately after an oil, fuel or chemical spill.
- A licensed waste management company should remove captured petroleum waste products from any oil, chemical or fuel spills and dispose responsibly.

With over 20,000 units operating worldwide, Stormceptor performs and protects every day, in every storm.

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CANADA: (800) 565 4801

Snow Storage Plan

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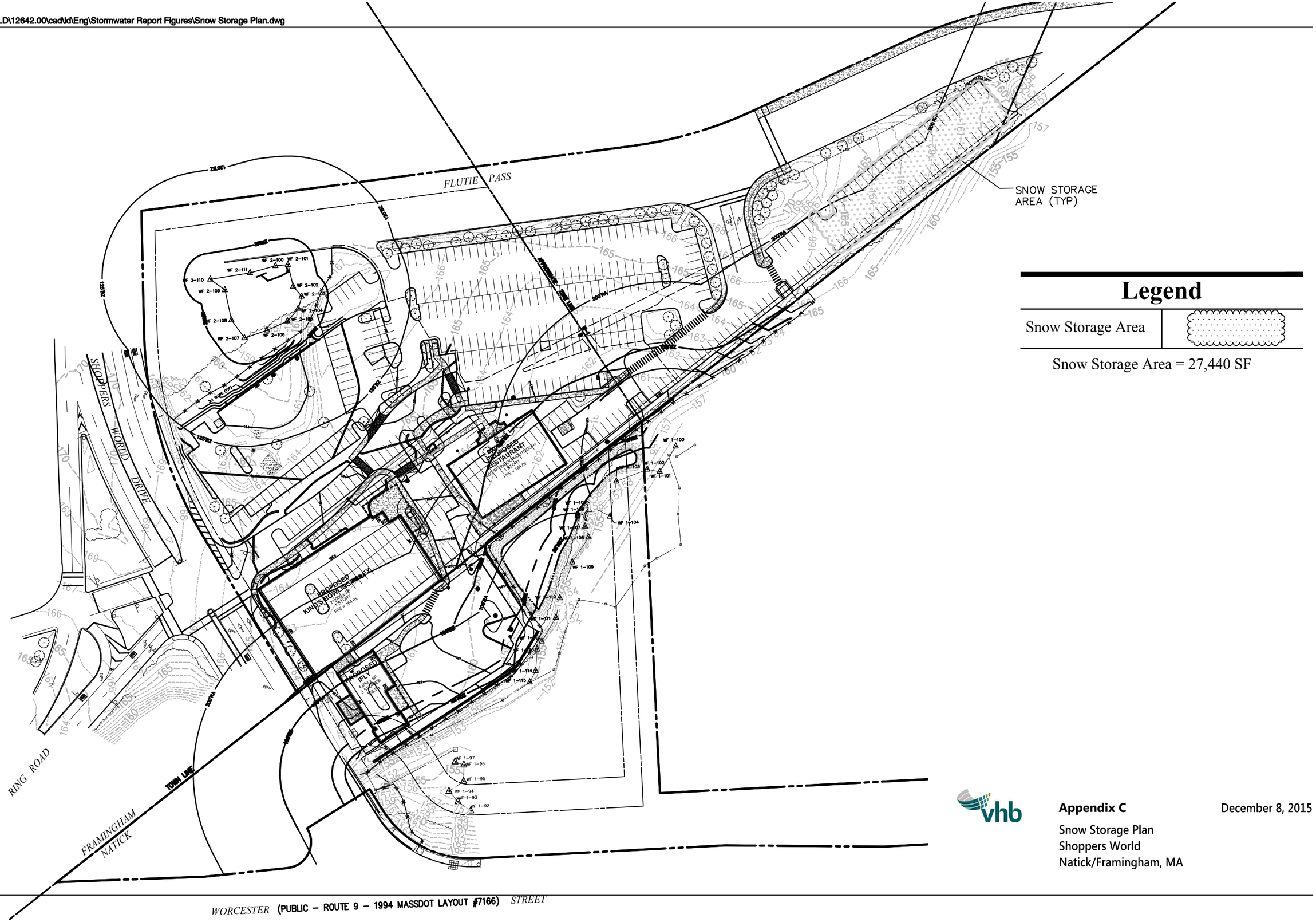

Legend

Snow Storage Area	

Snow Storage Area = 27,440 SF

Appendix C

Snow Storage Plan
Shoppers World
Natick/Framingham, MA

December 8, 2015

Appendix H
Hydraulic Analysis

The closed-drainage system has been designed to convey runoff from the 25-year storm event. Drainage pipes were sized using Manning's equation for full-flow capacity and the Rational Method for estimating runoff. The performance of the system was analyzed using StormCAD, a HEC-22 based program.

Included in this section:

- Closed-Drainage System Hydraulic Analysis

Closed-Drainage System Hydraulic Analysis

Vanasse Hangen Brustlin, Inc.
Transportation
Land Development

Environmental Services
101 Walnut St., Watertown, MA 02471
(617) 924-1770

Storm Drainage Computations

Name: **Shoppers World**
Location: **Framingham/Natick, MA**

Proj. No.: **12642.00**
Date: **8/3/2015**
Computed by: **PLH**
Checked by: **CPN**

Design Parameters:
Design Storm: **25 Year (Atlast of Rainfall Extremes)**

START	END	Upstream Inlet Area (acres)	Upstream Inlet C	System CA (acres)	Upstream Inlet Tc (hours)	System Intensity (in/h)	Manning's n	Diameter (in)	Rim (ft)	Length (Unified) (ft)	Invert (Start) (ft)	Invert (Stop) (ft)	Slope (Calculated) (ft/ft)	Velocity (ft/s)	Capacity (Full Flow) (cfs)	Flow (cfs)	Upstream Structure Hydraulic Grade Line (In) (ft)	Upstream Structure Energy Grade Line (In) (ft)
CB B1	DMH B2	0.2	0.77	0.154	0.083	6.004	0.011	12	163.5	52	160.5	160.2	0.006	3.53	3.2	0.93	160.9	161.06
DMH B2	DMH B4	0.48	0.9	0.586	0.083	5.955	0.011	12	163.1	131	160.1	157.8	0.018	7.51	5.58	3.52	160.9	160.94
CB B3	DMH B4	0.33	0.72	0.238	0.083	6	0.011	12	160.9	7	157.4	157.3	0.014	1.83	5.03	1.44	158.62	158.67
DMH B4	DMH B5	(N/A)	(N/A)	0.824	0	5.897	0.011	12	159.29	83	157.7	155.4	0.028	9.65	7.01	4.9	158.61	159.02
CB B6	DMH B5	0.45	0.77	0.347	0.083	6.004	0.011	12	159.2	13	155.6	155.4	0.015	6.28	5.22	2.1	156.36	156.52
RD - IFLY	DMH B5	0.14	0.9	0.126	0.083	6.004	0.013	8	160.8	159.1	158.8	155.7	0.019	4.71	1.69	0.76	159.21	159.39
DMH B5	WQU B7	(N/A)	(N/A)	1.296	0	5.868	0.011	12	159.2	14.8	155.3	154.9	0.027	9.76	6.92	7.67	156.38	156.49
WQU B7	EX DMH B8	(N/A)	(N/A)	1.296	0	5.863	0.011	12	159.25	25	154.8	154	0.032	10.92	7.53	7.66	155.78	157.27
EX DMH B8	EX FES B9	(N/A)	(N/A)	1.296	0	5.855	0.011	12	159.09	7	153.9	153.5	0.057	14.1	10.06	7.65	154.88	156.53
DCB A1	DMH A1	0.83	0.76	0.631	0.083	6.004	0.011	12	163.3	22	160.8	160.6	0.009	5.82	4.01	3.82	161.63	162.1
DMH A1	OCS A2	(N/A)	(N/A)	0.631	0	5.991	0.011	12	165.1	23.5	160.5	160.4	0.004	4.85	2.75	3.81	161.5	161.91
OCS A2	FES A1	(N/A)	(N/A)	0.631	0	5.975	0.013	12	164.7	24	160	159.5	0.021	7.16	5.14	3.8	160.83	161.29
CB C1	DMH C2	0.08	0.75	0.06	0.083	6	0.011	12	164.2	49	161.2	157	0.086	6.98	12.33	0.36	161.45	161.54
LD - 1	DMH C2	0.11	0.37	0.041	0.083	6	0.011	8	163.6	20	160.6	160.2	0.02	3.92	2.02	0.25	160.83	160.91
DMH C2	EX DMH C6	(N/A)	(N/A)	0.101	0	5.977	0.013	12	164.2	117	156.9	155.7	0.01	3.41	3.61	0.61	157.22	157.98
DCB C4	EX DMH C6	1.1	0.81	0.891	0.083	6.004	0.011	12	161.3	20	158.3	158	0.015	7.45	5.16	5.39	159.23	160.01
EX DMH C6	EX DMH C7	(N/A)	(N/A)	0.992	0	5.863	0.011	12	161.8	27	155.6	155.4	0.007	7.46	3.62	5.86	157.03	157.04
EX DMH C7	EX DMH C5	(N/A)	(N/A)	1.662	0	5.851	0.011	18	160.3	37	155.3	154.5	0.022	10.51	18.25	9.8	156.51	156.92
EX CB C8	EX DMH C7	0.87	0.77	0.67	0.083	6.004	0.011	12	160.5	49	156.5	155.1	0.029	9.36	7.12	4.05	157.35	157.85
EX DMH C5	WQU C10	(N/A)	(N/A)	1.746	0	5.839	0.011	18	160.8	26	154.4	154.2	0.008	7.01	10.89	10.27	155.63	156.97
WQU C10	EX FES C11	(N/A)	(N/A)	1.746	0	5.826	0.011	18	161.1	20	153.9	153.7	0.01	7.85	12.41	10.25	155.13	155.88
EX CB C12	EX DMH C5	0.14	0.6	0.084	0.083	6.004	0.011	12	160.3	18	155.6	154.8	0.044	6.13	8.88	0.51	155.9	156